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RECONNAISSANCE SENSOR SYSTEM EXPLOITATION

Rome Research Corporation

Richard R. Petroski

ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, New York 13441

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APPROVED: Kenneth R. Sharkey

KENNETH R. SHARKEY, SSgt, USAF
Project Engineer

APPROVED: Thadeus J. Domurat

THADEUS J. DOMURAT
Acting Chief, Intelligence & Reconnaissance Division

FOR THE COMMANDER: John P. Huss

JOHN P. HUSS
Acting Chief, Plans Office

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Kenneth Sharkey, SSgt, USAF (IRRE)

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Documented in this report are the primary tasks accomplished under project title, "Reconnaissance Sensor System Exploitation." The intent of the report is to offer a brief summary of the evaluations of reconnaissance sensor imagery and ground exploitation systems performed under the program. Also documented is the support provided by the Northeast Test Area and the Military Equipment and Engineering Array (MEDEA) at the RADC Stockbridge Test Site. Detailed information pertaining to any of the

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tasks completed during the contractual effort may be obtained from RADC (IRRE), Griffiss AFB NY 13441.

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EVALUATION

This final report documents the results of 24 months of Data Base operations, test area support for sensors, and sensor evaluation. This was accomplished by contractual personnel on-site at RADC and the Stockbridge Test Site.

The Data Base has been a valuable resource for multisensor aerial imagery, ground truth information, technical reports, test plans, and various types of map and chart products. More recently, it has become a resource for magnetic and digital tapes generated under a number of research and development programs. The Data Base provides a readily available source of information to aid in the solution of intelligence related problems.

Kenneth R. Sharkey

KENNETH R. SHARKEY, SSgt, USAF
Project Engineer

SECTION 1

INTRODUCTION

This report documents the activities performed under Contract F30602-78-C-0332; it covers the period 1 November 1978 through 17 November 1980.

The objective of this effort was to prepare test plans for the analysis and evaluation of advanced reconnaissance sensor systems. As such, the effectiveness of each sensor tested was determined. The performance characteristics for use in advanced sensor systems were established, and new techniques for the timely exploitation of intelligence imagery was developed.

Under this contractual effort, Rome Research Corporation's (RRC) program staff members also maintained, updated and improved the utility of the RADC/IRR Reconnaissance Data Base.

A number of USAF and other DoD programs were supported throughout the duration of the contract, and are discussed under the following five major tasks:

1.1 DATA BASE OPERATIONS

Since its inception in 1965, the Data Base has been a valuable resource for multisensor aerial imagery, ground truth information, technical reports, and various types of map and chart products. More recently, it has become a resource for magnetic and digital tapes generated under a number of research and development programs. It is unique in that it provides a readily available source of information to aid in the solution of intelligence problems concerning:

- Sensor System Development,
- Ground Exploitation Equipment Development,
- Real-Time Digital Exploitation,
- Image Recording, Processing and Reproductive Equipment Development,
- Multisensor Interpretation and Analysis Techniques,
- Target Location, Detection, and Identification, and
- Intelligence Information Reporting.

1.2 SENSOR/RECONNAISSANCE SYSTEMS EVALUATION

A major objective of this task was to determine the reconnaissance effectiveness of various airborne imaging systems, and to identify their performance characteristics and peculiarities. Ground exploitation equipment and techniques were evaluated and the results of image recording and processing systems were assessed. In addition, aerial imagery to which various digital processing techniques were applied was analyzed to evaluate the effectiveness of each technique.

Training in the interpretation of imagery acquired by advanced electro-optical systems was provided as part of this task.

1.3 FLIGHT PLANNING

Assistance in flight planning, and pre and post flight briefings for remote sensor flight test missions was provided as required throughout the duration of the contract. Reconnaissance mission planning consisted of the following requirements:

- Determination of the appropriate number of flight lines necessary to image the target area,

- Determination of the amount of film necessary to complete each data collection mission,

- o Recommendations for appropriate camera settings, and

- o Determination of aircraft flight altitude necessary to acquire the proper scale imagery.

1.4 TEST PLAN PREPARATION

Prior to flight testing reconnaissance sensor systems, it is necessary to develop a test plan that will reflect the test objectives; and that will show how these objectives are to be met. Primary emphasis must be on the preparation of the target site complex, development of targets, site maintenance, and collection of data to support a qualitative (subjective) and/or quantitative (statistical) evaluation.

Nine test plans were prepared and submitted to the RADC program engineer throughout the twenty-four months of this program.

1.5 NORTHEAST TEST AREA (NETA) SUPPORT

The Northeast Test Area (NETA) is comprised of two distinct entities:

1. Simulated NATO Tactical Targets, and

2. Military Equipment Display and Engineering Array.

It satisfies the existing need for a temperate zone test area and is comprised of three flight corridors and a designated boundary encompassing the Albany, N.Y. area. A total of seventy-two NATO target analogs exist within the boundaries of the flight corridors and the Albany area. Each target has been documented and updated with ground and aerial photographs (as they become available), and various types of ground truth data.

Twelve targets of primary interest have been selected to comprise the NORTHEAST TEST AREA/PRIMARY TARGET GROUP (NETA/PTG). Updating of information on these targets was of major concern during this program.

The Military Equipment Display and Engineering Array is located at the RADC Stockbridge Test Site, and complements the simulated NATO tactical targets. In addition to a large number of military vehicles and equipment, a variety of radar resolution arrays are surveyed into position at this site, and are available for side-looking-airborne radar (SLR) tests.

Throughout the contract, the site was configured to support a number of flight test programs. Maintenance was performed on all equipment located at the site, and ground truth documentation was accomplished during periods of sensor testing.

This report contains a description of the work performed under each of these five major tasks during the twenty-four months of the contractual effort.

SECTION 2

PROGRAM TASKS

2.1 TASK I - DATA BASE OPERATIONS

Throughout the duration of this contract, the RADC/IRR Reconnaissance Data Base was in operation to provide support to numerous RADC and other DoD programs.

The objective of this task was to maintain, update, and enhance a reconnaissance, multisensor data base in support of research and development programs and to prepare multisensor test photos and other photographic products to include microfilm data. Ordering and maintaining various types of maps, charts and map products became a very significant part of this task and proved to be a highly used resource available to the data base user. In addition, security classification downgrading instructions on all classified holdings were required to be reviewed and updated where necessary.

To accomplish the objectives of this first task, Rome Research Corporation's (RRC) program staff performed three basic functions:

1. Data Collection,

2. Data Reduction, and

3. Data Maintenance.

Tasks within the above mentioned functions are shown in Figure 2-1. A description of each task is outlined in the following subparagraphs.

2.1.1 Data Collection/Data Reduction

2.1.1.1 Imagery Collection and Reduction

Imagery from 63 missions was received and incorporated into the data base storage and retrieval system throughout the course of the contract. Data from 34 of these missions was in tape format. The RADC/IRR, Building #240 Computer Annex was used for softcopy viewing and analysis of imagery derived from analog (video tape) and digital magnetic tape formats. Figure 2-2 shows a diagram of this facility.

The following viewing modes were available for the softcopy review process:

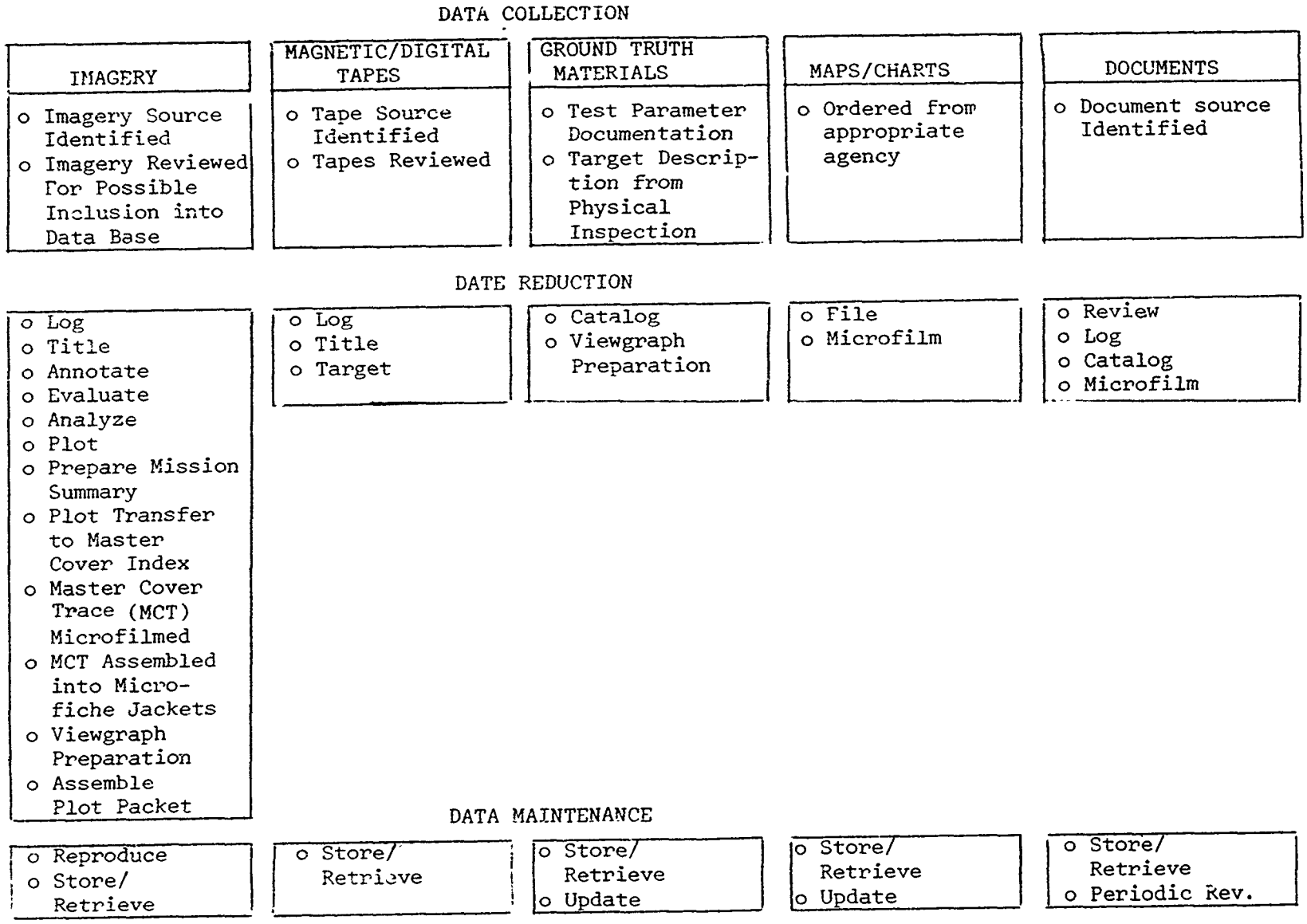


FIGURE 2-1. DATA BASE FUNCTIONS

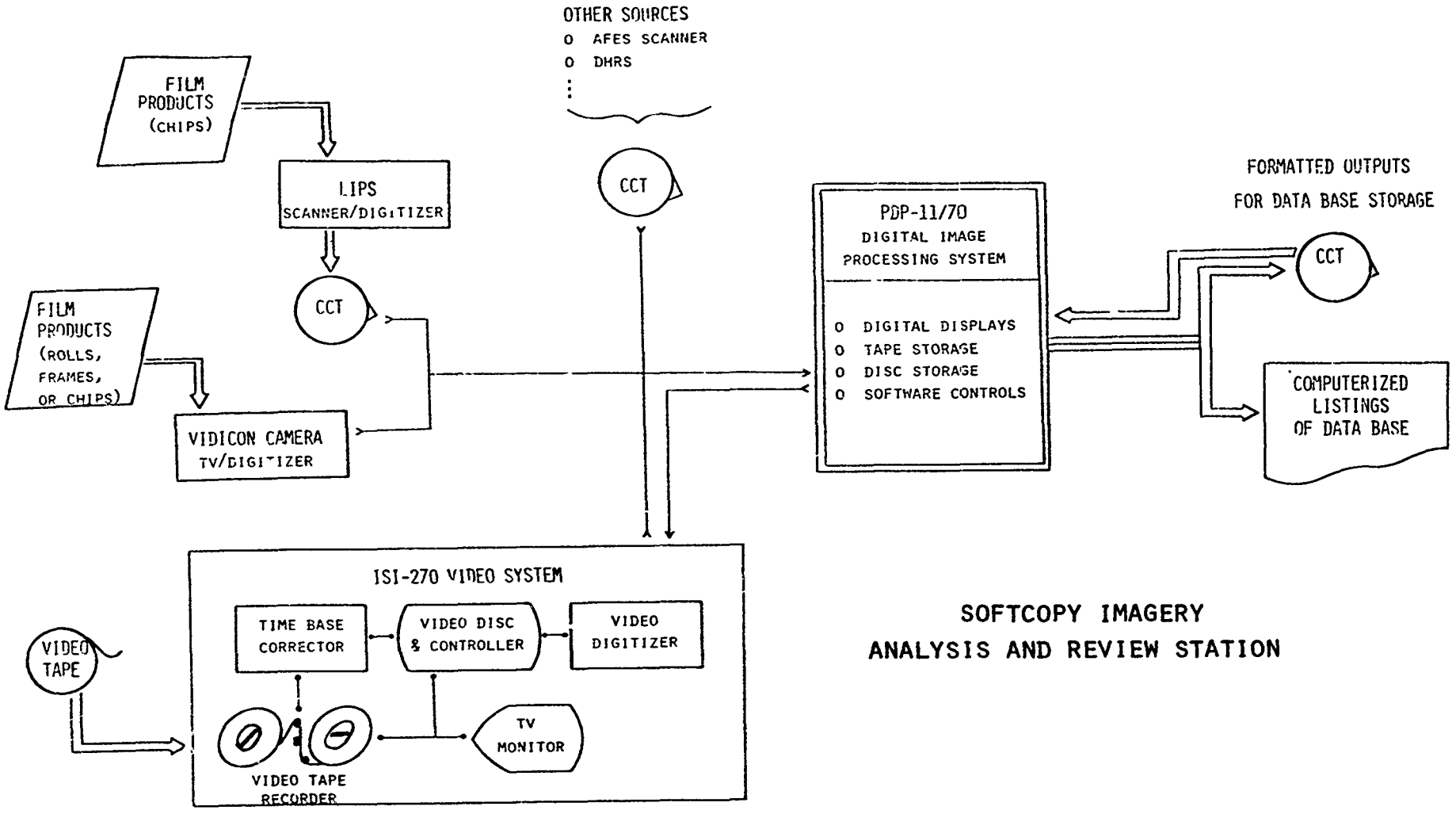

OTHER SOURCES
o AFES SCANNER
o DHRS
FILM PRODUCTS (CHIPS)
LIPS SCANNER/DIGITIZER
CCT
FILM PRODUCTS (ROLLS, FRAMES, OR CHIPS)
VIDICON CAMERA TV/DIGITIZER
CCT
PDP-11/70 DIGITAL IMAGE PROCESSING SYSTEM
o DIGITAL DISPLAYS
o TAPE STORAGE
o DISC STORAGE
o SOFTWARE CONTROLS
FORMATTED OUTPUTS FOR DATA BASE STORAGE
CCT
COMPUTERIZED LISTINGS OF DATA BASE
ISI-270 VIDEO SYSTEM
TIME BASE CORRECTOR
VIDEO DISC & CONTROLLER
VIDEO DIGITIZER
VIDEO TAPE
TV MONITOR
VIDEO TAPE RECORDER
SOFTCOPY IMAGERY ANALYSIS AND REVIEW STATION

FIGURE 2-2

o Real Time Mode

This mode (available as shown within the ISI-270 video system) was used for continuous viewing of imagery. Data was played back directly from video tapes and was viewed on the T.V. monitor. In certain instances, the data was transferred to the video disc (up to 20 seconds of data) to facilitate multiple playbacks for continuous viewing.

Other equipment used to view video tapes was the IVC 825 Recorder and the CONRAC T.V. Monitor.

o Stop Action Mode

The stop-action mode was used in several ways. The video tape recorder "freeze-frame" button was engaged to hold a given frame of imagery stationary on the display for several seconds, allowing the interpreter to more closely examine his area(s) of interest. Secondly, video data was transferred to the video disc and individual frames were selected for display.

Certain programs required that selected frames be digitized and analyzed on the PDP-11/70 Digital Image Processing System.

o Delayed Viewing Mode

In order to use the delayed viewing mode, the operator would transfer video data onto the video disc. This sequence of frames then could be easily played forward to backward in time at variable speeds through operation of the front panel switches on the ISI-270 disc controller.

o Flicker Mode

In this mode, individual frames of imagery were digitized and stored in the various image planes of the COMTAL display systems. A comparison of super-imposed frames was made when the operator would flicker back and forth between the two frames by controlling the front panel switches of the COMTAC display system.

A majority of the softcopy viewing and digitization requirements were in support of RADC's "Advanced Pattern Recognition" program and the "FLIR Imagery Enhancement" program.

Imagery from 29 missions was received in hardcopy format. Figure 2-3 illustrates the principal functions employed when reducing multisensor imagery and sensor tape data. Table 2-1 lists the types of imagery and sensor tapes that were received, the number of missions (listed by sensor type), and the program(s) or sources under which the imagery was collected.

Any collateral imagery or tape data such as flight logs, charts, and maps, and ground truth information were incorporated into a mission packet with the imagery plot, and was stored in the data base in a retrievable manner. In addition, a requirement existed to construct imagery packets in support of certain programs. Rolls of imagery and/or tapes that were thought to have contained the desired targets were earmarked for target analysis which would be accomplished under Task II of this program.

2.1.1.2 Document Collection and Reduction

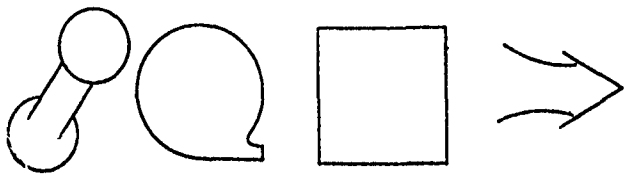
All technical reports and documents received in the data base during the twenty-four months of the contract were screened to determine if the information they contained was of value to the data base users. Documents that were found to be useful were logged into the data base storage and retrieval system. This process involves the following procedures:

1. Research of the storage and retrieval system to determine whether or not the document currently exists within the system;

2. Review the document to determine if the contents are of value to the data base user;

3. Determine if the proper security classification and downgrading instructions are on the document;

DATA REDUCTION FUNCTIONS



RADC/IRR Reconnaissance Data Base

Roll Film

Tapes

Collateral Data

- o Screening
- o Logging
- o Titling
- o Annotating/Targeting
- o Reproducing *
- o Plotting
- o Master Cover Index Preparation
- o Data Packet Preparation
- o Storing
- o Retrieving

* As requirements exist

FIGURE 2-3.

Imagery and Sensor Tapes Received in the Data Base

Sensor(s)/Image Type	Program-Source	Number of Missions Received
AN/AAD-5 Infrared (IR)	"Bold Eagle" QSR-USAF/TAWC	3
AN/AAD-5 IR	Special Agency I.R. Training/Orientation-Defense Intelligence Agency (DIA)	8
KA-76 (Ektachrome IR)	"Vegetation Stress Analysis As Indicative of Army Ammunition Plant Activities-U.S. Army, Aberdeen Proving Ground, MD	16
KA-62 (Ektachrome 2448 & Ektachrome IR 2443)	"Camouflage Target Detection" Program-U.S. Naval Reserve Training Mission	2
PAVE TACK FLIR (825 Line Scan) (TEAC 3,000 & Advisor-62 Tapes)	"Reforger 77," QSR Demo-U.S.A.F./ TAWC	13
PAVE TACK FLIR (Advisor-62 Tapes)	"Reforger 77"	19
FLIR (525 Line Scan)	"Bold Eagle," QSR-U.S.A.F./TAWC	2

TABLE 2-1

4. Assign a data base retrieval number to the document;

5. Log the document into the system, and

6. Prepare a sign-out card for the document.

During this contractual effort, over 19 cubic feet of outdated documents, and documents not relevant to the current RADC TPO's were destroyed. Currently, there are over 4,300 technical documents and reports held in the data base pertaining to the reconnaissance, remote sensing, and intelligence areas of interest.

2.1.1.3 Support Data Collection and Reduction

All collateral imagery data; i.e., intelligence/imagery interpretation reports, ground truth information, flight logs, etc., were logged into the data base to correspond with the appropriate roll of imagery or sensor data tape. A special area that had been set aside for storing imagery and ancillary mission data acquired during engineering test flights was maintained and updated.

2.1.2 Data Maintenance

2.1.2.1 Updating, Maintenance and Distribution of Maps, Charts, and Related Products

The most voluminous category of support data held in the data base is the map and chart file. The primary purpose of these maps and charts is to provide plotting bases for imagery coverage, as well as being used in mission planning. In addition, they offer users a comprehensive reference of those DMA products which have a broad application to all military type operations. However, during the past 24 months, the data base has received an influx of map and chart requests from various organizations within RADC. These requests were filled in support of numerous RADC programs.

The data base map and chart holdings cover all of CONUS and sections of foreign countries at various scales including:

- 1:24,000 USGS 7.5 Min. Series
- 1:25,000 DMA Series
- 1:50,000 DMA Series
- 1:62,500 USGS 15 Min. Series
- 1:200,000 Air Targeting Charts
- 1:250,000 Air Targeting Charts (JOGR)
- 1:250,000 AMS Series (Topographic)
- 1:250,000 JOG (A&G)
- 1:500,000 TPC's

- o 1:1,000,000 ONC's
- o 1:2,000,000 JNC

The requisitioning procedures for these products are outlined in DMA catalogs and are submitted on SF 344 Multiuse Standard Requisitioning/ Issue System Document (Figure 2-4).

USGS maps and charts were ordered by standard military letter from:

U.S. Geological Survey
1200 South Eads Street
Arlington, Virginia 22202

2.1.2.2 Updating and Maintenance of a Master Cover Index

A Master Cover Index depicting area coverage of the data base imagery holdings was updated and maintained throughout the tenure of the contract. All imagery plot sheets were keyed to AMS Series and V502 Series, 1:250,000 scale charts as a base for the master trace. The mission plots were traced on clear acetate material, keyed to the appropriate chart, and microfilmed with a 35mm Recordak microfilm camera on a reduction of 21X. Once the microfilm was processed, it was placed in microfilm jackets and filed in a retrievable manner in alphanumerical order according to chart designation. Personnel utilizing the data base viewed the microfilm products on a 3M Consultant 119, 35mm Microfiche reader with an 11.5X and a 24X lens.

DOCUMENT IDENTIFICATION

1 DOC IDEN	2 ROUTING IDEN	3 M&S	DOCUMENT NUMBER 9-10 REQUISITIONER	DOCUMENT NUMBER 11. DATE	13. DEM	14-15F SUPPLEMENTARY ADDRESS	16 SIG	17 FUND	18 DISTRIBUTION	19 PROJECT	20 PRIORITY	21 REQ DELIVERY DATE	SIGNATURE *(If required)*
1-3	4-6	7	30-35	36-39	44	45-50	51	52-53	54-56	57-59	60-61	62-64	
AOD	HMB	0	JM 1490	8 016			D				14		

REQUISITION DATA

F	5 STOCK NUMBER FIIN	6 ADDITIONAL	7 UNIT OF ISSUE	8. QUANTITY	12 SERIAL	14-15V SUPPLEMENTARY ADDRESS	16V SIG	18V DISTRIBUTION	19V PROJECT	22 ADVICE	NOTE: Entries in shaded blocks may be in either the FIXED (F) or VARIABLE (V) sections—NEVER in both
0-1	12-18	19-22	23-24	25-29	40-43	45-50	51	54-56	57-59	65-66	23 REMARKS
1501R	351939		EA	00006	0001					2B	
1501R	342160		EA	00012	0002						
1501A	NK1812		EA	00008	0003						
ONCXX	E04		EA	00006	0004						
TPCXX	F19D		EA	00160	0005						

Figure 2-4.

MULTIUSE STANDARD REQUISITIONING/ISSUE SYSTEM DOCUMENT

STANDARD FORM 344
JAN 1972 EDITION
GENERAL SERVICES ADMINISTRATION
FPMR (41 CFR) 101-26.2

The Master Cover Index was initiated by the RRC program staff under USAF Contract F30602-75-C-0172 in 1975 and was maintained and updated since that time. Since its initiation, it has proved to be a valuable resource in aiding the data base user to retrieve desired imagery more rapidly and effectively. In addition, this type of Master Cover Index:

a. Offers easy data handling,

b. Requires little storage space,

c. Offers easy viewing on the Recordak Magnaprint Reader, and

d. Allows a hardcopy record to be made if needed.

2.1.2.3 Data Base Services, Update and Maintenance

Once raw data were reduced and incorporated into the data base storage and retrieval system, project team members assisted all users in their retrieval of desired information. Requests varied widely in nature from a simple map order to a detailed interpretation and extraction of specific target information from a roll of imagery. Written requests that were approved by the appropriate authority have been satisfied throughout the tenure of the contract. The majority of requests were for multisensor imagery examples and various types of targets and target scenes on conventional aerial photography, and on thermal infrared and side-looking-radar imagery. However, the trend now appears to be moving toward requests for sensor tape data, and for information pertaining to ground exploitation systems, such as the ABLE-I, ATARS/LANTIRN and

TACIES, to mention a few.

During the course of the program, it became apparent that in the future, greater emphasis will be in the softcopy analysis of digital imagery in support of current RADC programs such as "Direct Digital Targeting (DDT)." In preparation for extensive research and analysis of multisensor images stored in magnetic and analog (video tape) formats, software has been developed for processing Laser Image Processing System (LIPS) formatted magnetic tapes. The developed system will allow the operator to choose from any four options to determine which part of the analyzing phase he/she wishes to go through. These options include:

1. Retrieving an image file from magnetic tape;
2. Creating sub-images ranging in size from 1 x 1 to 512 x 512 pixels (starting at any pixel location in the image file);
3. Displaying any of the sub-images or the DeAnza or COMTAL display; and
4. Exiting from the program itself after processing has been completed.

It should be noted that the images and sub-images are all stored using the Automated Feature Analysis Exploitation System (AFES) file structure of header and data files; so that any of the other options available under AFES for the processing of images may be used on these files. Contained in Appendix A is the dialogue that the user will encounter while using this program.

At the onset of the contract, methods to improve the layout of the entire 40' x 60' data base were identified and employed to allow cleaner and more efficient storage areas, more security control over materials, and more secluded and roomy working space for data base users and data base staff.

The data base facility was continually maintained and updated. Proper security classification and downgrading of roll film and documents were accomplished in accordance with AFR 205-1 and DoD 5200-1-R. All data that were of little value or not relevant to current or future R&D programs were deleted from the data base storage and retrieval system.

2.2 TASK II - SENSOR/RECONNAISSANCE SYSTEMS EVALUATION

Several evaluations were accomplished during the period of this program. Many of these evaluations varied considerably in their objectives and scope. Certain studies were designed to determine the reconnaissance effectiveness and performance capabilities of such sensor systems as the AN/AAD-5 IR scanner and the PAVE TACK FLIR, while others were initiated to assess the capabilities of ground exploitation systems.

Prior to performing any evaluations, a clear and complete objective of the evaluation was defined. These objectives included all or part of the following:

- o Overall Quality of Sensor Data
- o Image Quality Ranking
- o Image Interpretability Ranking
- o Image Resolution and Repeatability Determination
- o Analysis of Ground Exploitation Techniques, Such as Digitization Processes
- o Target Matrix Development

By satisfying these objectives, the necessary data has been gathered to:

1. Develop, where practical, new or improved ground exploitation processes; (an example of this would be the development of a certain digitization process which would enhance a target signature).

2. Develop, where practical, new or improved interpretation techniques. (An example of this would be recommending an improved means of change detection. One might consider the flicker technique, or the superimposing of one image scene onto another image scene acquired during a different time frame.)

3. Provide recommendations for use in the development of more advanced sensor systems, recording equipment, and processing equipment.

Another important requirement that was part of this second task, was the development of imagery test packets for use in testing ground exploitation systems. An example of this requirement would be the support provided to RADC's "Advanced Pattern Recognition" program. In support of this program, data base imagery holdings were researched for multisensor examples of the features listed in Table 2-2. Each image scene was evaluated for overall image quality and image feature selection. Selected scenes were duplicated, printed, annotated and incorporated into imagery test packets. Table 2-3 is an image feature list that was provided, along with the appropriate imagery, in support of the "Advanced Pattern Recognition" program.

FEATURES

A. Man-made (Cultural)

1. Railroad Tracks

   a. Single or Multiple
   b. Standard, Narrow or Broad Gauge

2. Roads

   a. Single, Double, Multiple or Divided Lanes
   b. Concrete, Asphalt or Dirt

3. Parking Lots

   a. Asphalt or Concrete

4. Buildings

   a. Flat, Gabled, Saw Tooth, Curved, Conical or Domed Roof
   b. Shingled, Crushed Stone and Tar, or Metal Roof

5. Bridges

   a. Suspension, Cantilever, Arch Truss, Deck or Movable Span
   b. Concrete, Steel or Masonry Construction
   c. Vehicle, Railroad or Pedestrian Use
   d. Spans Water, Roads, Railroad Tracks or Land

6. Airports

   a. Military or Civilian
   b. Major or Minor

7. Vehicles (From Large Scale Imagery)

   a. Tanks, Trucks, Airplanes or Helicopters

8. Towers

   a. Radio, Television, Microwave, Power Transmission or Observation
   b. A, H, I, or Y Type Construction

9. Storage Tanks

   a. Cylindrical Flat Top, Cylindrical Dome Top, Cylindrical Peaked Top, Spherical, Spherical with Column Support, Blimp or Bullet

TABLE 2-2

ADVANCED PATTERN RECOGNITION PROGRAM FEATURE REQUIREMENTS

B. Natural (Terrain)

1. Water

    a. Lakes, Rivers, Ponds, Streams, Reservoirs or Canals, etc.

2. Forest Land

    a. Coniferous, Deciduous or Mixed Trees

3. Grass Land

    a. Tended or Not Tended

4. Desert

5. Cultivated Land

    a. Corn, Wheat, Rice, Vineyards, Sugar, etc.

6. Barren Land

    a. Soil, Rock or Brush

7. Permanent Snow or Ice

TABLE 2-2
(continued)

IMAGE FEATURE EXAMPLES
FOR ADVANCED PATTERN RECOGNITION

#1 - Schenectady Mission GR74-20 Sensor RC-8 Date - 16 May 74 Time - 12:25 Alt. - 6,000' Scale - 1:12,000	• Multiple and single railroad tracks • Railroad cars • Two lane concrete road • Flat roof buildings • Cylindrical flat top storage tanks • River • ⩚ and pyramid shaped transmission towers • Coniferous and deciduous trees • Sewage treatment facility
#2 - Schenectady Mission GR74-20 Sensor RC-8 Date - 16 May 74 Time - 12:25 Alt. - 6,000' Scale - 1:12,000	• Single railroad track • Single concrete and dirt roads • Concrete parking lot • Flat, gabled and curved roofed buildings • Major military and civilian airport • Deciduous trees • Tended grass • Airplanes and cars
#3 - McKeever Bridge Mission GR75-003 Sensor RC-8 Date - 8 Jan 75 Time - 11:20 Alt. - 6,000' Scale - 1:12,000	• Beam bridge concrete pilings, blacktop surface, steel girder • Walkway on west side • Residential buildings • Fire road dirt • River • Mixed forest
#4 - Stockbridge Mission GR74-020 Sensor RC-8 Date - 16 May 74 Time - 9:50 Alt. - 4,000' Scale - 1:8,000	• Dirt roads • Ponds • Towers (test and support) • Barn, gabled roof • Mixed forest
#5 - Stockbridge Mission GR74-020 Sensor RC-8 Date - 16 May 74 Time - 9:50 Alt. - 4,000' Scale - 1:8,000	• Mixed forest and scrub land • Gable roof barn • Dirt roads • Cultivated fields (unknown crop type)

TABLE 2-3

#6 - Canastota Mission GR74-20 Sensor RC-8 Date - 16 May 74 Time - 10:44 Alt. - 3,000' Scale - 1:6,000	• Vehicles (airplanes) • Two lane road (asphalt) • Parking lots • Flat, gabled buildings shingled, metal, crush stone and tar roof • Civilian minor airport • Deciduous and coniferous trees • Tended grass • Concrete runway
#7 - Canastota Mission GR74-20 Sensor RC-8 Date - 16 May 74 Time - 10:44 Alt. - 3,000' Scale - 1:6,000	• Canal • Railroad tracks • Residential homes, gabled, hipped and valley roofs • Swimming pool • Buildings - flat roof, gabled roof (metal and tar) • Parking lot • Tended and non-tended fields • Cars • Telephone lines
#8 - Scotia Depot Mission GR76-16 Sensor KC-1B Date - 8 Sep 76 Time - 10:15 Alt. - 10,000' Scale - 1:20,000	• Single and multiple railroad tracks • Two lane and divided roads (asphalt and concrete) • Flat and gabled buildings, shingled and metal roofs • Concrete deck, vehicle bridge, span road • A-type transmission towers • Cylindrical flat top storage towers • River • Deciduous trees • Grass
#9 - Scotia Mission GR76-16 Sensor KC-1B Date - 6 Sep 76 Time - 10:15 Alt. - 10,000' Scale - 1:20,000	• Single and multiple railroad tracks • Two lane and four lane roads (asphalt and concrete) • Parking lots • Flat and gabled buildings, shingled and metal roofs • Deck, concrete, vehicle bridges, span land and water and railroad • Trucks • River, pond, stream • Coniferous and deciduous trees • Tended grass • Baseball fields

*Clouds evident in film clip.

TABLE 2-3
(continued)

#10 - Phoenix Mission 68-56 Sensor KC-1B Date - 17 Dec 68 Time - 14:50 Alt. - 7,000' Scale - 1:14,000	• Buildings (monitor roof, vallied gabled roofs) • Storage tanks - flat top • Cultivated field vs. uncultivated • Parking lot • Highways - four lane • Dirt roads
#11 - Phoenix Mission 68-56 Sensor - KC-2B Date - 17 Dec 68 Time - 14:50 Alt. - 7,000' Scale - 1:14,000	• Storage tank peaked • Water tower • Smoke stacks • Cultivated fields (rough and texture) • Hipped roofs • Slag piles
#12 - Phoenix Mission 68-56 Sensor KC-1B Date - 17 Dec 68 Time - 15:15 Alt. - 7,000' Scale - 1:14,000	• Buildings (saw-tooth roof, arched roof, flat with stone and tar roof) • Parking lots • Untended fields • Major highway • Vehicles
#13 - Phoenix Mission 68-56 Sensor KC-2B Date - 17 Dec 68 Time - 15:15 Alt. - 7,000' Scale - 1:14,000	• Roads (major four lane, minor two lane) • Canal • Bridges (deck over land and water) • Drive-in-theater • Residential housing area (gabled roofs) • Trailer park • Cars

TABLE 2-3
(continued)

One last requirement that was accomplished under Task 2 was the development and delivery of a Thermal Infrared Training Program. In support of this requirement, program staff members researched data base imagery holdings, and imagery holdings at the Defense Intelligence Agency in Arlington, Virginia for examples of thermal infrared imagery to be used in the training course. The development of the training course was accomplished in the following five phases:

- o Phase I - Development of a course outline and training schedule
- o Phase II - Research and selection of training materials (to include thermal infrared imagery).
- o Phase III - Preparation of training presentations/lectures.
- o Phase IV - Preparation of training materials (viewgraphs, imagery training packets, and training manuals).
- o Phase V - Delivery of training course (accomplished in two phases, during two different time frames).

Tables 2-4 and 2-5 are training course outlines that were used for this training program. Copies of the training manuals are available in the RADC/IRR Reconnaissance Data Base; however, distribution is limited to Government agencies.

TRAINING PHASE I

Day 1 - Introduction to Infrared

0730-0745	Introduction and Administrative Comments
0745-0800	History
0800-0830	Overview of Aerial Applications
0830-0840	Break
0840-0910	FLIR Presentation
0910-0930	Terminology/Glossary Preview
0930-0940	Break
0940-1110	IR Theory and Principles
1110-1215	Lunch
1215-1345	IR Characteristics and Peculiarities
1345-1400	Break
1400-1430	Confidence Scaling
1430-	Wrap-Up

Day 2 - IR Target Signatures and Interpretation *

0730-0800/1145-1230	Overview
0800-0830/1230-1300	Introduction to Naval OB
0830-0840/1300/1310	Break
0840-0910/1310-1340	Introduction to Air OB
0910-0925/1340-1355	Introduction to Ground OB
0925-0955/1355-1425	Introduction to Missiles and Electronic OBs
0955-1005/1425-1435	Break
1005-1015/1435-1445	Oil Refinery Study
1015-1045/1445-1515	Propulsion Wind Tunnel
1045-1100/1515-1530	Closing Remarks

* To be present four times to 10 different interpreters each time.

TABLE 2-4

PHASE II

NPIC IR TRAINING

DAYS 1, 2, 4, 5 (MON, TUE, THUR, FRI)

	0730	0830	0930	1030	1130	1200	1300	1400	1600
Petroski	HC/GOB	HC/GOB	SC/NOB	SC/NOB	LUNCH	SC/GOB	Open	HC/NOB	HC/MOB
Sharkey	SC/AOB	SC/AOB	HC/AOB	HC/AOB	LUNCH	OPEN	HC/MOB	OPEN	SC/EOB
Butters	OPEN	OPEN	OPEN	OPEN	LUNCH	HC/ST	SC/ST	SC/ST	OPEN
				DAY 3	WED				
Petroski	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
Sharkey	OPEN	HC/EOB	OPEN	HC/EOB	LUNCH	OPEN	HC/EOB	OPEN	HC/EOB
Butters	HC/ST	OPEN	HC/ST	OPEN	LUNCH	HC/ST	OPEN	HC/ST	OPEN
NPIC,	IDIMS	IDIMS	IDIMS	IDIMS	LUNCH	IDIMS	IDIMS	IDIMS	IDIMS
Zanon,	½	1	½	1		½	1	½	1
Zoracki	Hour	Hour	Hour	Hour		Hour	Hour	Hour	Hour

HC - Hard Copy
SC - Soft Copy
AOB - Air Order of Battle
GOB - Ground Order of Battle
NOB - Naval Order of Battle

EOB - Electronic Order of Battle
MOB - Missile Order of Battle
ST - Special Targets
IDIMS - Interactive Digital Image Manipulation Systems

TABLE 2-5

Brief summaries of each evaluation accomplished under this program are presented to document the objective, evaluation methodology, and where possible, the results. Detailed information on each evaluation can be obtained by contacting RADC/IRRE; Griffiss AFB, N.Y. 13441.

2.2.1 Physical Parameters/Image Characteristics

Sensor data quality of all imagery received in the Data Base was assessed in terms of certain image characteristics, such as contrast, tonal range, geometric fidelity and resolution. These measurements were extracted from film or from digital representations of film data. Image quality of forward-looking infrared (FLIR) video data was also evaluated to determine the reconnaissance effectiveness of FLIR imagery.

o Image Contrast and Tonal Range

Whenever required, these values were determined by measuring on test film calibrated against a standard grey wedge. Consistency of contrast and tonal range over the width of all imagery evaluated was determined by members of the project team.

o Geometric Fidelity

As applied to optical systems represents a measure of the dimension and shape reproduction accuracy of the sensor systems. Determination of

distortion caused by numerous conditions such as camera vibration, lens abberation, image motion compensation (IMC) error and others was recorded on all imagery evaluated. Line scan systems have many factors which can influence geometric fidelity (and resolution) such as detector alignment, mirror jitter, scan start/stop time, and sample time. Where information was available on the ground position and dimensions of certain identifiable targets within an image scene, calculations were made to determine errors in positional accuracy and target measurements. The degree of mensuration precision required was specified in the test plan directives associated with the sensor evaluation.

o Resolution Measurements

When specified in test plan directives, image resolution in both Line of Flight (LOF) and Cross Line of Flight (XLOF) was measured. Since most photography received in the data base was not flown over a Standard Military Bar Target, the primary means used to determine the approximate resolution of collected imagery was to perform measurements of the smallest object which could be differentiated from its surroundings.

Ground Resolution depends upon film resolution, lens resolution and imagery scale. To measure ground resolution, the following formula was used:

$$G = \frac{h}{(f)(R_{LF})(25.4)}$$

where: G = Ground resolution in feet

h = Height (Aircraft altitude, AGL)(above ground level in feet)

R_{LF} = Lens/film resolution (lines/mm)

Measurement of infrared ground resolution at nadir was calculated from the following formula:

$$d_o = h\Delta\Theta$$

where: d_o = One side of the resolution element in feet

h = Aircraft altitude (AGL)

$\Delta\Theta$ = Angular resolution in radians

Measurement of radar resolution is normally accomplished by analyzing Synthetic Aperture Radar (SAR) imagery of corner reflector arrays arranged in a configuration designed to allow the image interpreter to determine if target separation exists, and thus assign a resolution value both in azimuth and range. No SAR imagery was received in the data base during this contract; therefore, no radar resolution measurements were made.

2.2.2 Evaluation of Conventional Aerial Photography

All conventional aerial photographic missions received in the data base were evaluated to determine:

- o Overall image quality,
- o Adequacy of ground coverage (was the target area adequately imaged?),
- o Presence of film processing problems,
- o Adequacy of overlap between frames (where applicable), and
- o Occurance of camera malfunctions.

Evaluations of the performance of the camera as a function of altitude and/or scale was one of the objectives typically encountered.

There was no evidence of camera malfunctions on any of the conventional photographs received in the data base. Inadequate lens filtering and film processing problems were apparent on five of the KA-76 (Ektachrome IR) missions received from Aberdeen Proving Grounds, MD. However, the imagery was interpretable and provided updated coverage of several U.S. Army Ammunition Plants in the United States.

Table 2-6 lists the number of conventional aerial photographic missions by camera type, evaluated during the twenty-five months of the program. Average ground resolution measurements, and overall image quality is included.

SUMMARY OF PHOTOGRAPHIC MISSIONS EVALUATED

Camera	Number of Missions Evaluated	Average Ground Resolution	Overall Image Quality
KA-76 (Ektachrome IR, 2443)	16	.82'	Fair-Excellent
KA-62 (Ektachrome, 2448)	1	.26' - .44'	Good
KA-62 (Ektachrome IR, 2443)	1	.75'	Good

TABLE 2-6

2.2.3 AN/AAD-5 Thermal Infrared (T.I.R.) Imagery Evaluations

Eleven AN/AAD-5 T.I.R. missions were analyzed and evaluated prior to their incorporation into the RADC/IRR Reconnaissance Data Base. The overall image quality was recorded on the roll film label and on the mission data packets. Targets were identified on each mission for use in ground exploitation equipment evaluations and training programs.

All AN/AAD-5 T.I.R. imagery received met both thermal and spatial resolution requirements. Some sensor malfunctions occurred throughout certain missions; however, this did not effect the overall quality of the imagery, which ranged from fair to excellent.

2.2.4 Evaluation of PAVE TACK FLIR Tapes

PAVE TACK FLIR tapes from 34 different missions were evaluated at USAF/TAWC, Eglin AFB, Florida and at RADC. FLIR video from each tape was viewed on a CONRAC 17C video display monitor. Each video scene was analyzed to determine:

- o Scene quality,
- o Amount of noise, jitter, etc. apparent on each scene,
- o Number and type of targets imaged on each scene, and
- o Interpretability of each target recorded.

Missions containing designated types of tactical targets were copied using an IVC 825A recorder. A log was compiled which recorded all targets contained on each mission tape by time-segment. All tapes were properly labeled and classified prior to incorporation into the RADC/IRR Reconnaissance Data Base storage and retrieval system. This data is earmarked to be targeted for use on the Direct Digital Targeting (DDT) Program.

2.2.5 Evaluation of Picture Coding Techniques

Under RADC Contract F30602-75-C-0082, staff members from Purdue University applied several picture coding techniques to conventional aerial reconnaissance photos for the purpose of comparative evaluation. Both spatial and frequency domain methods were used: five of them previously known, as well as two new ones.

Source encoding is intended to reduce non-essential (to the user) redundancy in original imagery, but this increases the sensitivity of the source-encoded data to communication channel noise. Thus channel encoding (efficient bit apportionment/quantization, data formatting, and added redundancy for error detection and correction) is necessary to minimize this noise sensitivity. [1]

1 Coding of Aerial Reconnaissance Images For Transmission Over Noisy Channels, RADC-TR-78-210, September 1978.

Photo comparisons made by four members of Rome Research Corporation's program staff and one U.S.A.F imagery interpreter were all subjective. Analyses were made on noise free images as well as those coded and subjected to a simulated noisy transmission channel prior to decoding. The bit error rates used were 0, 10^{-4}, 10^{-3}, and 10^{-2}.

The specific coding methods evaluated were:

- o Fixed Zonal
- o Four Class Zonal (Chen and Smith)
- o Hybrid
- o Micro-Adaptive Picture Sequencing (CDC)
- o Block Truncation, and
- o Variable Noise.

The evaluation was conducted in support of RADC/DCC.

2.2.6 Micro Adaptive Picture Sequencing (MAPS) Image Compression Evaluation

In support of the "MAPS Image Compression" program, samples of compressed imagery were reviewed and evaluated. This evaluation was based on comparing the image scenes, which are made up of differing compression ratios and sub-frame staggering patterns. Fifty-five paired comparisons of six sets of imagery were evaluated. A total of 330 images were analyzed by three RRC image interpreters and one U.S.A.F. image interpreter. Results of this evaluation will be published in an RADC T.R. at a later date.

2.3 TASK III - FLIGHT TEST PLANNING AND COORDINATION

Assistance in the area of flight planning was provided throughout the term of the program. Support in planning missions was provided by:

- Supplying the requesting engineer with the appropriate charts overprinted with the necessary flight lines to obtain the area coverage desired.

- Researching sensor operating parameters for the engineer when requested.

- Assisting in determining the appropriate aircraft altitude.

- Briefing and debriefing aircrews.

The majority of flight planning assistance was provided to agencies flying sensor tests over the Northeast Test Area and the RADC, Stockbridge Test Site.

2.4 TASK 4 - TEST PLAN PREPARATION

Prior to flight testing reconnaissance sensor systems and other electronic airborne equipment, it was necessary to prepare a test plan that would reflect the test objectives; and that would show how these objectives would be met.

When developing test plans, the primary emphasis was on the following area:

- o Preparation of Target Site Complex (Stockbridge Test Site)
- o Development of Targets and Target Situations
- o Test Site Maintenance, and
- o Collection of Data to Support a Qualitative (Subjective) and/or Quantitative (Statistical) evaluation.

Throughout the tenure of the contract, assistance was provided in the preparation of nine test plans that were submitted to the RADC program engineer in support of the following programs:

- o Wide Area Anti-Armor Munitions (WAAM) Program,
- o Multi-Band Image Data Collection Program,
- o Infrared (IR) Seeker/Sensor Target Evaluation Program,
- o Camouflage Detection Using Thermal Contrast,

- o Millimeter Contrast Guidance Demonstration
- o MOD. VIII, Millimeter Wave Seeker Program,
- o WAAM/Millimeter Contrast Guidance Demonstration,
- o WAAM/IR Seeker Tests,
- o MRS^3/MASER Programs, and
- o Camouflage Concealment and Deception (CC&D) Data Collection Program.

Contained in Appendix B is a test plan which was prepared by ERIM for the WAAM program. RRC program staff members provided input to this test plan and to the other eight test plans listed above.

2.5 NORTHEAST TEST AREA (NETA) SUPPORT

The Northeast Test Area (NETA), developed for RADC in 1971, satisfies the long existing need for a temperate zone sensor test area. Centered in New York State, the NETA greatly facilitates reconnaissance study of communications systems, industrial and military complexes, and topographical features representative of world temperate zones.

Features characteristic of the Northeastern United States which replicate world temperate zones, and in particular Europe, are:

- o Climate - continental with maritime influence,
- o Topography - plains, mountains, and river systems,

- o Vegetation - soft and hardwood forests, pastoral and agricultural lands, and
- o Target Types - industrial, communication, military and topographic.

The shaded portion of the map shown in Figure 2-5 locates the NETA with respect to the Northeastern United States.

2.5.1 Tactical Targets

Approximately seventy-two New York State targets representative of the standard 25 NATO tactical target categories have been selected and documented for use in sensor evaluations over the NETA. Figure 2-6 shows the areal boundaries and location of three flight corridors and a designated boundary encompassing the Albany, New York area where the NATO tactical targets are located. Considering only the areal boundaries of these corridors, the topographic and urban analogies shown in Table 2-7 are provided for in Central New York. Within normally accepted flight procedures, no severe flight restrictions exist within these corridors.

2.5.1.1 Maintenance and Update of Northeast Test Area Primary Target Group (NETA/PTG)

Of the seventy-two tactical targets located in the NETA, twelve have been selected for the Primary Target Group of the Northeast Test Area. It is anticipated that the primary targets listed in Table 2-8 will be

The shaded portion of the map locates the NETA with respect to the Northeastern United States. Griffiss AFB provides a centrally located staging area for missions over all targets located in the NETA and others within the 300 nautical-mile local-mission radius of the base.

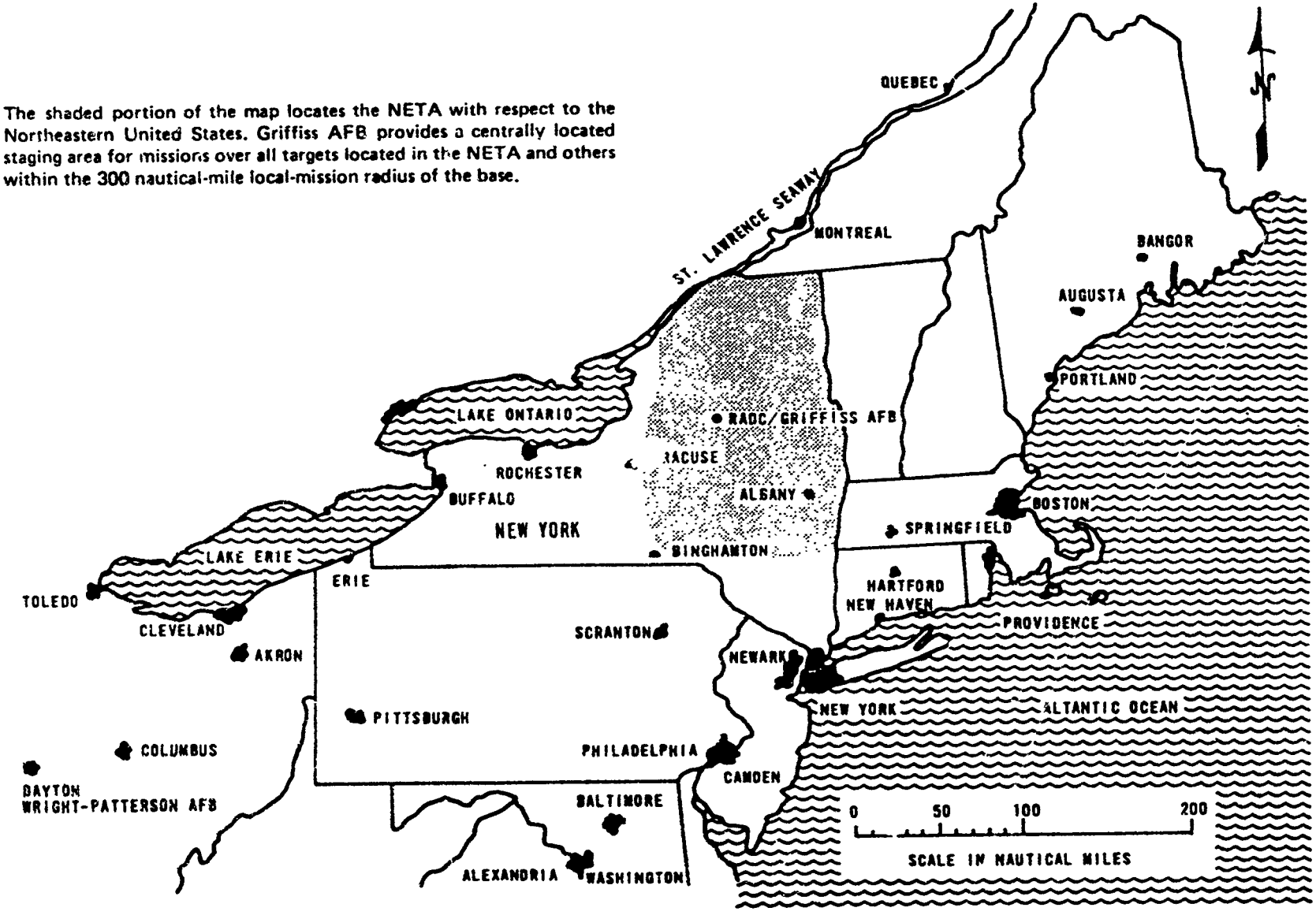


FIGURE 2-5. Location of NETA

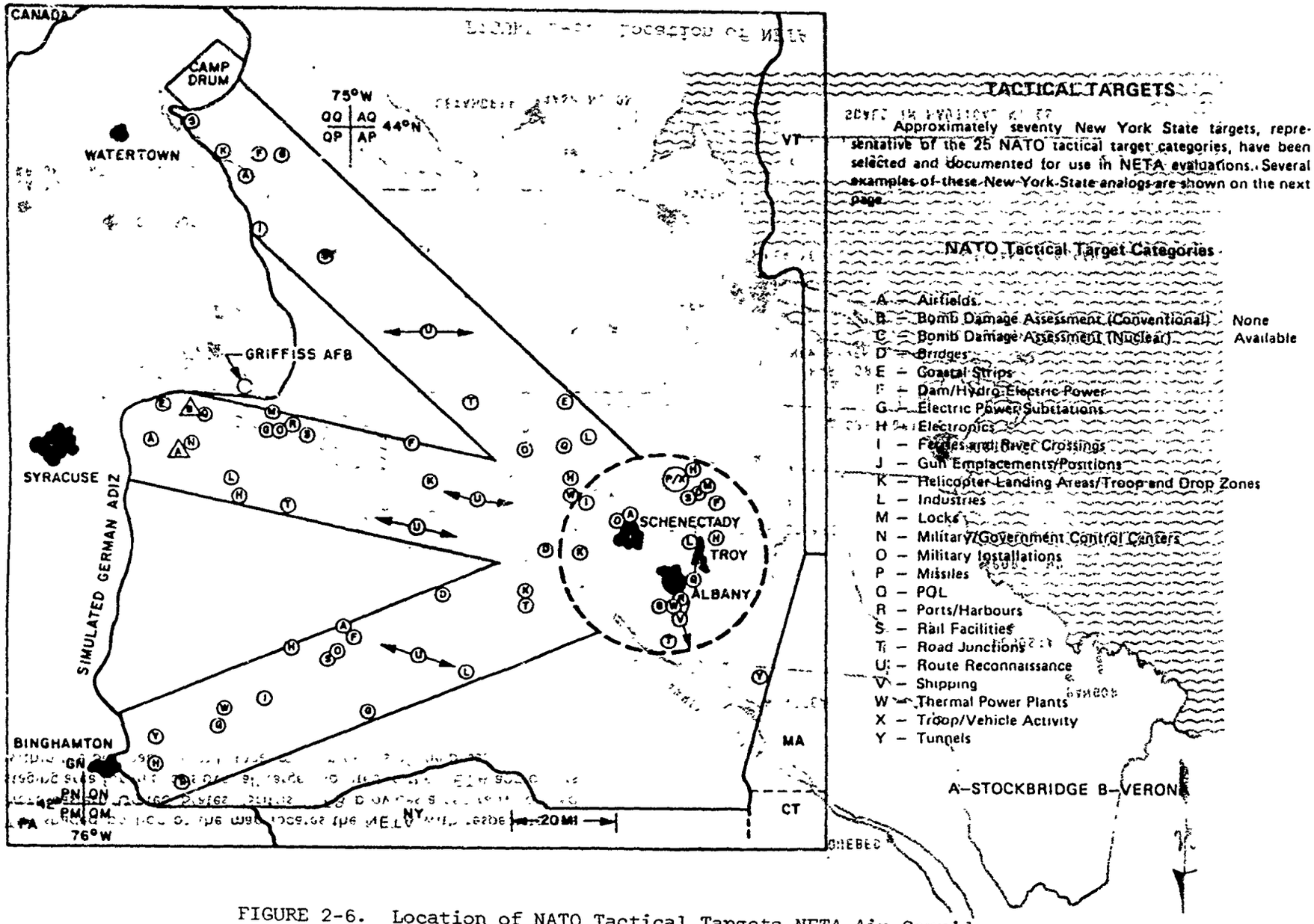


FIGURE 2-6. Location of NATO Tactical Targets NETA Air Corridors

AIR CORRIDOR ANALOGIES

CORRIDOR	ANALOGIES
NORTH (Albany - Watertown)	Landforms and vegetation similar to the largely forested Berlin-Frankfurt Southern Air Corridor are replicated. The New York Corridor is sparsely populated and thus allows low altitude flying.
CENTRAL (Albany - Syracuse)	Contains communication parallels for the autobahn and canal, and railroad lines are present that can be found in the Berlin-Hannover Central Air Corridor. The New York Corridor also offers medium urban and industrial complexes.
SOUTH (Albany - Binghamton)	Features both terrain and communications analogous to the small urban/agricultural pattern of the Berlin-Hamburg Northern Air Corridor.
RING (Albany Environs)	Representative of the East-West Berlin area, where large industrial, military and urban complexes are found.
OPEN ENDS of Each Corridor (Watertown - Syracuse - Binghamton)	The cities are analogous to the large and small industrial complexes of Hamburg, Hannover and Frankfurt.

Table 2-7

NORTHEAST TEST AREA PRIMARY TARGET GROUP (NETA/PTG)

AIRFIELDS:

*Griffiss Air Force Base - 43° 14'N 75° 25'W
Canastota Municipal Airport - 43° 04'N 75° 46'W

DAM/HYDROELECTRIC POWER

*Dam/Water Retention, Lake Delta - 43° 16' 13"N 75° 27'W
Ingham Mills, H.E.P. - 43° 03'N 74° 46'W

ELECTRIC POWER SUB-STATIONS

Yahnundasis Station - 43° 05'N 75° 20'W

INDUSTRIES

*Revere Copper and Brass - 43° 05'N 75° 20'W

LOCKS

Marcy Lock #20 - 43° 08'N 75° 17'W

MILITARY INSTALLATIONS

*Camp Drum, New York - 44° 02' 30"N 75° 44' 30"W

POL

Pump and Storage, Buckeye Copeland, Verona - 43° 08'N 75° 36'W

TABLE 2-8

PORTS AND HARBORS

N.Y.S. Barge Canal Basin, Utica - 43° 07'N 75° 13'W

RAIL FACILITIES

Utica Rail Road Yard Penn Central, Utica - 43° 07'N 75° 13'W

THERMAL ELECTRIC POWER

Albany Steam Plant - 42° 36'N 73° 46'W

*New NETA Target

TABLE 2-8
(continued)

used more extensively in future sensor tests.

In April 1980, a more detailed treatment of the selected NETA/PTG began in order to:

- o Increase the amount of useable data for selected targets;
- o Further develop requirements for target data, i.e., more extensive ground truth;
- o Utilize to a greater extent available multisensor imagery of the selected targets; and,
- o Perform detailed target signature analysis as permitted by available imagery.

The first requirement in establishing the NETA/PTG was to select existing NETA documented targets for study, based upon frequency of past use and general interest in the R&D and intelligence communities. A candidate list of fifteen targets was compiled based upon target features of possible interest. This list was reduced to twelve targets by eliminating redundancy in types and further study of interesting features. Four new targets, not part of the original seventy-two, were added as part of the NETA/PTG.

The twelve primary targets were chosen for detailed study using the following criteria.

- o Target/sensor attributes,
- o Current use and interest to related programs,
- o Proximity to Griffiss AFB, and
- o Access for ground truth purposes.

Target folders were developed for the four new NETA/PTG targets, and existing target folders for the remaining eight targets were updated.

2.5.2 Military Equipment Display and Engineering Array - Stockbridge Test Site

The Military Equipment Display and Engineering Array (MEDEA) complements the simulated NATO tactical targets of the NETA. The MEDEA is located at the RADC Stockbridge Test Site, situated approximately twenty-four miles southwest of Griffiss AFB, New York. The site consists of 500 acres of open fields and wooded areas and is positioned on the crest of North-South oriented spur 800 feet above the surrounding terrain. Over the years, this site provided a tactical setting for realistic target groups that may pose a threat in a battlefield situation. During a period of time, the target groups remained in surveyed positions; however, because of the diversity of the many sensor test programs conducted at Stockbridge, it became necessary to re-configure the site for each specific test. Therefore, all of the targets no longer remain in target groups, but rather are dispersed throughout the site.

When a requirement exists to utilize the test site for sensor test programs, it is re-configured according to test plan specifications. It is this ability to prepare the site in various configurations that makes the MEDEA a unique asset to the intelligence and reconnaissance communities.

Table 2-9 is a listing of tactical equipment located in the MEDEA.

In addition to tactical military equipment, a variety of radar resolution arrays and test pads are available and are surveyed into position for side-looking-airborne radar (SLR) tests. (See Figure 2-7.)

2.5.2.1 MEDEA/Stockbridge Test Site Support

Throughout the duration of this program, the following types of support were provided to various sensor test programs:

- o Camouflage Pattern Painting of Targets,
- o Camouflage Net Assembly and Disassembly,
- o Assistance in Test Plan Preparation,
- o Test Site Configuration,
- o Ground Truth Data Collection,
- o Provision of Target Mobility, and
- o Site Surveying.

TACTICAL EQUIPMENT

Armor

3 M48 Tanks
1 M59 APC
2 M84 APCs
1 M44 SP Gun
3 M55 SP Guns
1 M48 Dummy Tank

Wheeled Vehicles

20 ¼ T M38 (Jeeps)
7 2½ T Trucks (Box Body)
13 2¾ T Trucks (Cargo)
7 2½ T Trucks (Tankers)
1 5 T Truck with Honest John Missile

AAA

1 90mm AA Gun
2 40mm AA Guns
1 40mm Dummy AA Gun
1 Radar Trailer

SAM

2 Radar Trailers
1 Radar Antenna (On Wheels)
1 Generator, Trailer Mounted

Artillery

3 8" Cannons
2 Snowcats
1 1½ T Cargo Trailer

Engineering

1 14' Boat
1 Flatbed Trailer
1 Crane
1 200 Gallon Water Trailer
1 Generator, Trailer Mounted

Camouflage Netting

10 Woodland Synthetic Radar Scattering Nets and Modules

TABLE 2-9

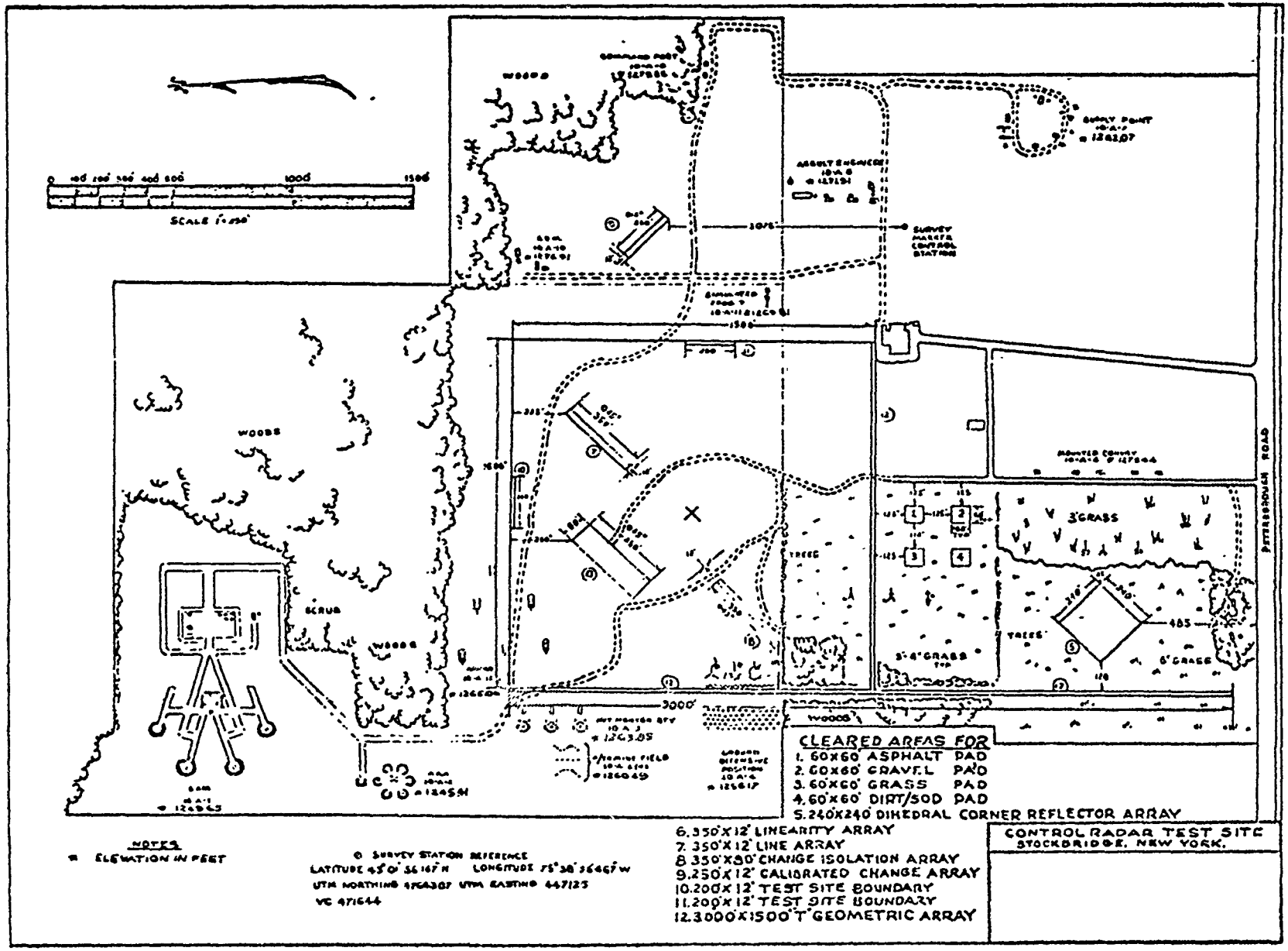


Figure 2-7 Stockbridge Control Radar Test Site

A brief summary of support provided in preparation for and during sensor test programs is described in the following subsections.

2.5.2.1.1 Wide Area Anti-Armor Munitions (WAAM) Program

The WAAM program was an Air Force Armament Laboratory (AFATL) sponsored program, conducted to test the development of millimeter-wave (MMW) seekers in direct support of the tactical anti-armor role for the European scenario.

Support provided included the following:

- o Assistance in test plan preparation,
- o Site surveying for target positioning,
- o Target mobility (Movement of 2 M60 tanks during periods of sensor tests).

Table 2-10 is an excerpt from the WAAM Test Plan and offers more detail of the support provided.

2.5.2.1.2 Multi-Band Image Data Collection Program

The Multi-Band Image Data Collection Program was a DARPA program by the Air Force Avionics Laboratory (AFAL) at Wright Patterson AFB, Ohio. The objective of the effort was to obtain signature data on structures which exist at or are in the general vicinity of Griffiss AFB, New York and targets

CAPTIVE FLIGHT TESTS

Test range and target requirements - the Stockbridge Test Site will be the primary flight test location. The flight profile will consist of a modified racetrack pattern over-flying various armor type targets. The exact location and placement of each target will be determined at a test planning meeting. The required target types and number of targets are as follows: three M-48 tanks two M-55 self-propelled guns, one M-113 armored personnel carrier and two operational M-60 tanks (provided by New York National Guard. The target grouping and locations will be established at the above-mentioned test planning meeting, but it is anticipated that there will be approximately five locations and groupings as indicated on the attached drawing. It will be required to rearrange and relocate the targets periodically per the detailed flight test plan to be provided by DLMT before November 1978. A limited number of tests will be conducted against moving tank targets, M-60s, along the range roads parallel to mixed conifer tree line. Contractor-provided Luneberg lens calibration targets and calibrated passive plate targets will be placed at strategic locations along the flight path. The exact locations are to be determined at the planning meeting.

Special support requirements consisting of the following: FPS-16 tracking radar support for each mission (beacon track), recorded TSPI data and pin plots from the radar, radio communication between the aircraft and the ground test personnel, ground truth weather data in the target area, and still and movie color photographic coverage. The TSPI recorded data format should be in accordance with the following specification:

Radar TSP Data Tape Format

7 or 9 track

BCD

EXCERPT FROM WAAM TEST PLAN

TABLE 2-10

and backgrounds at the Stockbridge Test Site. Support provided included:

- o Input to test plan,
- o Test site configuration,
- o Site surveying, and
- o Target mobility (movement of M60 tanks).

More detail of the support provided can be obtained from excerpts of the test plan shown in Table 2-11.

2.5.2.1.3 Infrared (IR) Seeker/Sensor Target Evaluation Program

This program was conducted by AFAL and follows a scenario closely related to the WAAM requirements.

Support requirements included:

- o Input to test plan,
- o Site surveying,
- o Site configuration (Dynamic and Static tests), and
- o Target mobility.

2.5.2.1.4 Camouflage Detection Using Thermal Contrast

This RADC sponsored program required extensive target preparation prior to sensor testing. Forty-one tactical vehicles were camouflage

MULTI-BAND IMAGE DATA COLLECTION TEST PLAN

TEST OBJECTIVES:

At DARPA, a requirement exists to obtain signature data on structures which exist at or in the general vicinity of Griffiss AFB, New York, and at AFATL a requirement exists to obtain signature data on targets and backgrounds available at Stockbridge. To support these requirements, target signatures will be acquired with the instrumented ERIM C-7 aircraft of the SAC and POL areas on Griffiss AFB and the Delta Dam in the vicinity of Griffiss AFB, and target and background signatures will be acquired at the Stockbridge test site. Flights will be conducted at altitudes of 500-5000 feet at all sites except the Stockbridge area where 270-5000 feet altitudes will be required. To support this effort, a UH1F helicopter, assigned to Eglin AFB, FL will also fly missions at the Stockbridge site during or in between the C-7 aircraft passes over the site. The Defense Mapping Agency will conduct a geodetic survey of those areas prior to and during the flight test effort to support these requirements.

TEST ITEM DESCRIPTION

DMA will conduct a geodetic survey of the SAC and POL areas on Griffiss AFB, the Delta Dam in the vicinity of Griffiss AFB, and the Stockbridge site. At specific points on buildings or on the ground in these areas, ERIM will install optical reflectors, radar reflectors and calibration panels. The IRRTS thermal calibration source will be parked at the Stockbridge site. After installation is completed, the C-7 aircraft will fly over these sites at specific altitudes gathering the signature data. For flights over the Stockbridge site, the UH1F helicopter will be flying over the site gathering data during or between passes over the site by the C-7 aircraft. M-60 tanks and other vehicles will be exercised during the Stockbridge tests and the IRRTS thermal calibration source will be operating.

TABLE 2-11

patterned and spray painted using "Camouflage ALKYD Enamel," Specification MIL-E-52798, which is a fairly new synthetic camouflage paint. Table 2-12 lists the types of vehicles painted. Prior to the conduct of tests, vehicles were positioned according to a test plan, and were camouflaged with different types of netting and natural foliage. Ground truth data was collected during periods of overflights.

2.5.2.1.4 Millimeter Wave Contrast Guidance Demonstration

This program was initiated to help support the development of millimeter wave (MMW) seekers. Independent measurements of targets and clutter and targets immersed in clutter were required for an extensive data base to support adequate seeker design and evaluation of approaches for the WASP and CYCLOPS MMW concepts. An object of the WAAM technology support programs was to gain quantitative information concerning the background reflectivity and emissivity characteristics of clutter and targets in clutter as applicable to detection and tracking analysis for terminal guidance and millimeter wave seekers and sensors.

This AFAL sponsored program followed the same test plan as the WAAM programs; however, it was conducted in two phases; Phase IIA-MCGD Tower Tests and Phase IIB-MCGD Captive Flight Tests. The two phases covered a total time period from October 1978 through June 1979 with Phase IIA running from October 1978 through January 1979 and Phase IIB, from February 1979 through July 1979.

CAMOUFLAGE PATTERN PAINTED VEHICLES

M48 Tank	3
M84 APC	2
M59 APC	1
M55 SP Gun	3
¼ Ton Jeeps	12
2½ Ton Trucks	14
2½ Ton Fuel Trucks	6
TOTAL	41

TABLE 2-12

An excerpt from the test plans for Phase IIA is included in Table 2-13 and outlines the support provided.

Phase IIB support is identical to the support provided during the WAAM program tests.

2.5.2.1.5 MOD VIII Millimeter Wave Seeker

This Aeronautical Systems Program Office (Wright Patterson AFB, Ohio) sponsored program required the testing of a millimeter wave radar. One of the requirements in the development of the program was to collect target signature data in a seasonal change environment (fall/winter) of no snow to light snow conditions. Flight tests were conducted during November and December 1978.

Support provided included:

- o Target position documentation, and
- o Recording of weather conditions.

2.5.2.1.6 WAAM/Millimeter Contrast Guidance Demonstration

Program requirements have been previously outlined under the WAAM tests and the Millimeter Contrast Guidance Demonstration.

MILLIMETER CONTRAST GUIDANCE DEMONSTRATION

SUPPORT REQUIREMENT (PHASE IIA)

Support Requirements. In order to support the test requirements of this development effort, the following support and resources are required.

a. Phase IIA - Tower Tests

1. Use of the 1200 feet VLF transmitter tower at Forestport, New York will be required from October 1978 through January 1979. This includes the installation of weather-proof enclosures at the 300 feet, 600 feet, and 1200 feet levels for equipment and personnel protection. Approximately 600 to 800 pounds of equipment will be installed on the tower. Only one level (300', 600', or 1200') will be used at any one time, thereby reducing the wind loading effects. A source of 115V AC 60 Hz/60 Amps power (3-20 Amp services) will be required at each level. It will be necessary for three or four contractor personnel and one Air Force personnel to be on the tower at the operating level during the active tests. Testing will be conducted during normal duty hours with limited access required at night and on weekends.

2. Maintenance and office space will be required in the building at the base of the tower or other suitable facilities. Both Air Force and contractor personnel will require access to the tower and supporting buildings.

3. Access to the cleared area around the base of the tower out to approximately 1200 feet as well as to the perimeter road (approximately) 2400 feet) for temporary placement of contractor-provided targets (radar corner reflectors, $50m^2$, $100m^2$, and $300m^2$) will be required.

4. We will require two M-60 tank targets initially located at approximately 500 feet and 1000 feet from the base of the tower. These tanks will be provided by the New York National Guard. Periodic relocation of the tanks will be required. Surveyed coordinates, look-down angle, and slant ranges (from the three tower levels) to each of the selected target locations will be required (approximately 10 locations). Licensed drivers and maintenance personnel as well as POL for these tanks will be required from RADC.

5. Photo documentation will be required of the MCG system installation and target placement. Both still and moving pictures color coverage are required. Approximately 50 exposures, still photography, and 200 feet of 16 mm movie film will be required during this phase.

TABLE 2-13

2.5.2.1.7 WAAM/IR Seeker Tests

Program requirements have been previously outlined under the WAAM tests and the IR Seeker/Sensor Target Evaluation Program.

2.5.2.1.8 MRS^3/MASER Programs

The support requirements for the MRS^3/MASER program were similar to those of the WAAM programs.

Targets were positioned in various locations throughout the Stockbridge Test Site and nine road tests, involving two M-60 tanks were conducted during captive flights.

2.5.2.1.9 Camouflage Concealment and Deception (CC&D) Data Collection Programs

In support of this program, the Stockbridge Test Site was configured according to a test plan jointly prepared by the sponsoring program agency and RRC personnel.

Targets were positioned under camouflage netting, tarps, and trees prior to data collection. In addition, smoke was provided to conceal certain targets. Ground truth data was collected during periods of sensor testing, and engineering drawings were prepared and provided to the sponsoring agency.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

It is the conclusion of Rome Research Corporation's program staff that the tasks identified in the Research and Technology Statement of Work have been completely satisfied. Results derived from sensor and ground exploitation system evaluations are useful and as a result, should have a direct bearing on the development of future systems. It is further concluded that:

- The input provided to the various sensor test plans was an essential factor in the successful accomplishment of the many program objectives to which this type of support was rendered;

- The RADC/IRRE Reconnaissance Data Base has proven to be a valuable resource available to the intelligence and reconnaissance communities, and has directly influenced the successful accomplishment of a variety of R&D studies and imagery interpretation training programs;

- Assistance provided by the data base staff was invaluable in providing the necessary technical support required by RADC and other U.S.A.F. and DoD programs;

- Mission planning support was an essential part of test plan preparation, and the acquisition of different types of sensor data; and

- The Northeast Test Area (NETA) and the Military Equipment Display and Engineering Array (MEDEA), located at the Stockbridge Test Site, provided an excellent test area for numerous data acquisition sensor systems, and satisfied the need for a temperate zone sensor test area. The Stockbridge Test Site was fully utilized throughout the course of the contractual effort.

3.1 RECOMMENDATIONS

Over the past two years, there has been a decline in the amount of aerial imagery received in the data base. A major factor influencing this decline is that relatively few new reconnaissance sensor systems have been developed during this time frame. However, there is a major thrust in the development of ground exploitation systems such as the Manual Radar Reconnaissance Exploitation System (MARRES), ABLE-1, and the Direct Digital Targeting System (DDT). To properly develop and evaluate these systems and others, a large amount of multisensor reconnaissance imagery is required, therefore; the following recommendations are offered by RRC's program staff:

1. Date base imagery holdings should be thoroughly reviewed on a regular basis to assure that adequate support data is available for the

development and testing of ground exploitation systems. Imagery and tape data must contain the targets required to fill the scenarios that are to be incorporated into the development of these systems.

2. Where data is lacking, other sources of imagery should be researched and obtained for input into the RADC Reconnaissance Data Base. The Defense Intelligence Agency (DIA) and USAFE are two primary sources of imagery containing tactical targets.

3. Archaic imagery holdings conta' .ing little target information should be purged from the data base storage and retrieval system, and should be replaced with current data.

4. Equipment for viewing video tapes should be set up in the data base facility for viewing and targeting tape data in support of ground exploitation system programs. Such a capability would allow the image interpreter to target video tape data without tying up the computer system located in the building #240 annex.

5. To adequately provide the data base user with required target examples or examples of imagery collected by certain sensor systems, standard imagery test packets should be developed and incorporated into the data base storage and retrieval system.

6. Current sensor summaries and summaries of ground exploitation systems should be prepared to document pertinent information concerning these systems. The history of system development should be documented in these summaries showing improvement in system performance as technology advances.

7. "Data Base Information Bulletins" should be prepared periodically to to keep the intelligence and reconnaissance communities aware of new materials and support that are available.

8. The imagery master cover index should be maintained and updated on a regular basis. A special index should be developed for sensor tape and digital data.

9. The NETA/PTG target folders should be updated with current ground truth data and aerial imagery. New targets should be added to the PTG as requirements exist.

10. More military equipment that is in running condition should be procured for the MEDEA at the Stockbridge Test Site.

11. Additional "Synthetic Woodland Radar Scattering Camouflage Nets" should be procured for use during future camouflage, concealment and deception (CC&D) programs.

12. Consideration should be given to building decoy and dummy targets at the Stockbridge Test Site for use during future CC&D programs; and

13. The availability of the MEDEA should be advertised internally and to various DoD agencies in an effort to promote its use and to increase funds for continued development and maintenance of the NETA.

APPENDIX A

DEVELOPMENT OF THE RADC/IRRE DATA BASE DIGITAL TAPE HOLDINGS

```
/************************************/
/* file name: manual.db             */
/* date of last update: 20-nov-90   */
/* programmer: marsha l. rauke      */
/*             rrc                  */
/************************************/
```

DEVELOPMENT OF THE NADC/IRME DATA BASE DIGITAL TAPE HOLDINGS

****

INTRODUCTION

****

The following section provides the dialogue that the user will encounter while using this program. The program is meant to be an aid to the user in cataloging a collection of magnetic tapes. The program can only handle tapes with image stored in LIPS format. The user may retrieve an image off of magtape and create subimages from anywhere in the image. The subimages may then be displayed on the CONTAL display to enable the user to determine the positions of various targets. The user may then catalog the tape and the image(s) on it with all the necessary information.

The format of this documentation is such that the system or program response occurs at the left hand margin with an explanation of the expected operator response occurring on the right hand side of the page. Occasionally, a brief explanation of what the program is doing will occur between system prompts. Error messages are listed at the end of the documentation with possible reasons for the occurrence of the error.

****

PROGRAM NAME: det_image (determine image)

****

DIALOGUE:

SYSTEM:	USER RESPONSE:
Image Processing by IFAG/AFES	
User:	Enter own user account name.
Password:	Enter appropriate password.
Once prompt shows, may run the program. (Note: all of the image(s) / subimage(s) created are stored in the /u/db directory)	
?	/u/marsha/db/det_image
The following menu is displayed:	
Image Retrieval Categories	
0 - explanation of categories	
1 - read image from magtape	

2 - get subimages
3 - display subimages
4 - exit image retrieval

Category = Enter desired option.

If 0 is entered:

1 - This routine allows the user to read an image off of magtape that was stored in LIPS format and store the file on the disk.

2 - This routine allows the user to create a subimage from the image stored on the disk. This subimage may vary in size from 1 X 1 to 512 X 512 pixels, and may start at any pixel location.

3 - This routine allows the user to display the subimage(s) he/she has created.

4 - User has completed processing and categorizing the image file(s) - exit the program.

The menu is displayed again.

Category = Enter desired option.

If 1 is entered:

Enter input device: Enter a 0 or 1 depending on the magnetic tape drive on which the tape is mounted.

Enter image file name: Enter appropriate name for the image file. (ie., image1)

The image is read from magtape.

The menu is displayed again.

Category = Enter desired option.

If 2 is entered:

The directory containing all of the image file names is displayed on the terminal. No response necessary.

Enter image file name: Enter name of image file to be processed.

Enter subimage name: Enter appropriate file name for the subimage to be created (ie., subimg10)

If the subimage name already exists:

Subimage name already exists.

Overwrite subimage information?(y/n) Respond 'y' to overwrite the existing file or 'n' to exit this option and get a chance to enter another subimage file

name.

Continue correct program performance.

Enter starting row position:	Enter pixel position indicating the row at which to begin withdrawing the subimage. (ie., 0 -> last row position in image)
Enter starting col. position:	Enter pixel position indicating the column at which to begin withdrawing the subimage. (ie., 0 -> last column position in image)
Enter #rows in subimage:	Enter number of rows to be included in the subimage. (min. 1, max. 512)
Enter #cols. in subimage:	Enter number of columns to be included in the subimage. (min. 1, max. 512)
The subimage is created.	
The menu is displayed again.	
Category =	Enter desired option.
If 3 is entered:	
The directory containing all of the subimage file names is displayed on the terminal.	No response necessary.
Enter view name:	Enter file name of the subimage to be displayed on the screen. NOTE: 'view0' may not be displayed.
Channels available are R B G.	
Enter channel:	Enter channel the subimage is to be displayed in - R (red), B (blue), G (green).
The subimage is displayed on the screen.	
The menu is displayed again.	
Category =	Enter desired option.
If 4 is entered:	
The magtape is rewound and the program is exited from.	No response necessary.

****

ERRORS

****

The category you have chosen is not valid.	The option entered was not one listed in the

[illegible]	menu.
Drive number must be 0 or 1.	Invalid entry for the input device.
Error opening magtape drive.	Possible hardware problem or tape not mounted properly.
Error creating/opening files for image. Error writing header file. Error opening image files. Error reading header file. Error creating/opening files for subimage. Error writing to subimage header file. Error occurred reading file. Unexpected end-of-file.	Could be software error or /w directory is full.*
r = n Error reading magtape - problem with drive or there are no more images on this tape.	If n = -1 then an error occurred; if n is anything else it indicates the actual number of bytes read.
w = n Error writing to image data file. /w directory may be full.	If n = -1 then an error occurred; if n is anything else it indicates the actual number of bytes written.*
Invalid starting position. Subimage size exceeds limit (512,512)	Invalid entry for starting position or size of subimage.
Error closing magtape drive. Error closing image header file. Error closing image data file. Error closing subimage header file. Error closing subimage data file.	Self-explanatory.
r = n EOF reached before processing complete.	n will be equal to 0 or -1; EOF was reached before the subimage could be read from the image file.
r = n Error occurred reading image data file.	Could be a software error or /w directory is full.*
w = n Error occurred writing to subimage data file. /w directory may be full.	Same as "Error writing to image data file".*
Image not available.	Image requested does not exist in the specified format.
View not available.	Subimage file name given to be displayed does not exist or the subimage file cannot be displayed.
Invalid channel.	Channel specified is not available.

NOTE: If the /w directory is full, operator will encounter problems with trying to process any files storing images/subimages. To help alleviate this problem with space, some or all of the files should be deleted to create some more space on the system. Do an 'ls //db' to get a listing of all of the image files. To remove each unwanted image - 'delete -r /*/dr/imagename';

APPENDIX B

TEST PLAN

APPENDIX B

TEST PLAN

STOCKBRIDGE TEST SITE

Wide Area Anti-Armor Munition

(WAAM PROGRAM)

- BASE OF OPERATIONS: GRIFFIS AFB, ROME, NEW YORK
- TIME PERIOD: NOVEMBER 1978
- DEPRESSION ANGLES: 20^{o} AND 75^{o}
- AZIMUTH ANGLES: 180^{o} AND 0^{o}
- SLANT RANGE: 800 FT
- SPECTRAL BANDS: 3 - 5 μM, 8 - 12 μM, 3.2 MM AND 1.06 μM RANGE
- INFORMATION BANDWIDTH: 300 KHz ON DIGITAL MAGNETIC TAPE
- DATA PROCESSING: FULLY CORRECTED LINE SCAN DATA (60 RUNS)

  LTN-51 CORRECTIONS TO LINE SCAN DATA (30 OF ABOVE RUNS)

  30' TRIANGULAR ARRAY FOR COMPARISON OF GEOMETRIC DISTORTION IN CORRECTED IMAGES

GEOMETRIC TEST ARRAY

STOCKBRIDGE TEST SITE

PURPOSE: COMPARISON OF GEOMETRIC DISTORTION IN FULLY CORRECTED IMAGES AND LTN-51 CORRECTED IMAGES.

SIZE: 30′ X 30′ RIGHT TRIANGLE WITH MARKER SPACINGS OF 3′ AND 6′.

LOCATION: SEE MAP.

MATERIAL: 12″ X 12″ SKY REFLECTORS (ALUMINUM FOIL) PLACED ON THE GROUND.

SURVEY: RIGHT ANGLE AND CORNER ESTABLISHED BY DMA

BENCH MARKS

STOCKBRIDGE TEST SITE

SURVEYED POINTS:	32 BY DMA
EXTENDED POINTS:	16 BY ERIM
LOCATIONS:	SEE MAP
CONFIGURATION:	2' X 4' PANEL WITH 10" X 10" SKY REFLECTOR IN ONE CORNER
MOUNTING:	A) ON GROUND WHERE POSSIBLE (VISIBLE AT 20^{0} DEPRESSION ANGLE)
	B) ON POST H FT ABOVE GROUND TO CLEAR VEGETATION

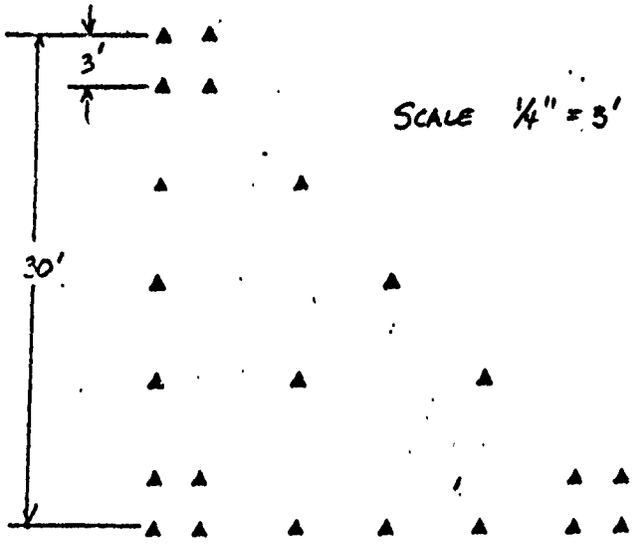
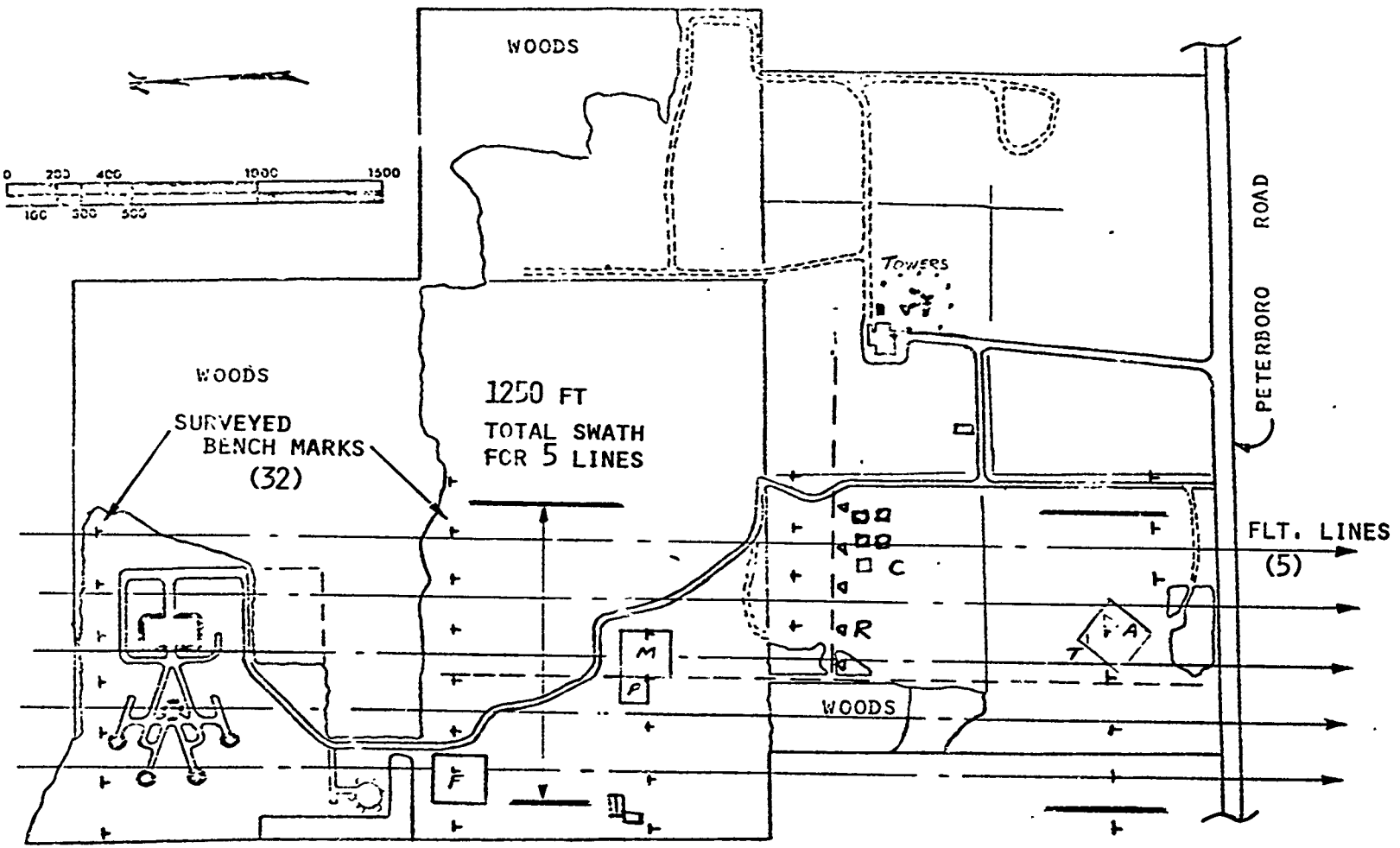


FIGURE 2. BENCH MARK ARRAY SUGGESTED
FOR AIRCRAFT MOTION CORRECTION PROCESSING EVALUATION

NUMBER OF MEASUREMENT
VERSUS LENGTH OF MEASUREMENT FOR BENCH MARK ARRAY

LENGTH	NUMBER
3 FT.	12
6 FT.	8
9 FT.	7
12 FT.	8
15 FT.	6
18 FT.	4
21 FT.	6
24 FT.	4
27 FT.	8
30 FT.	4



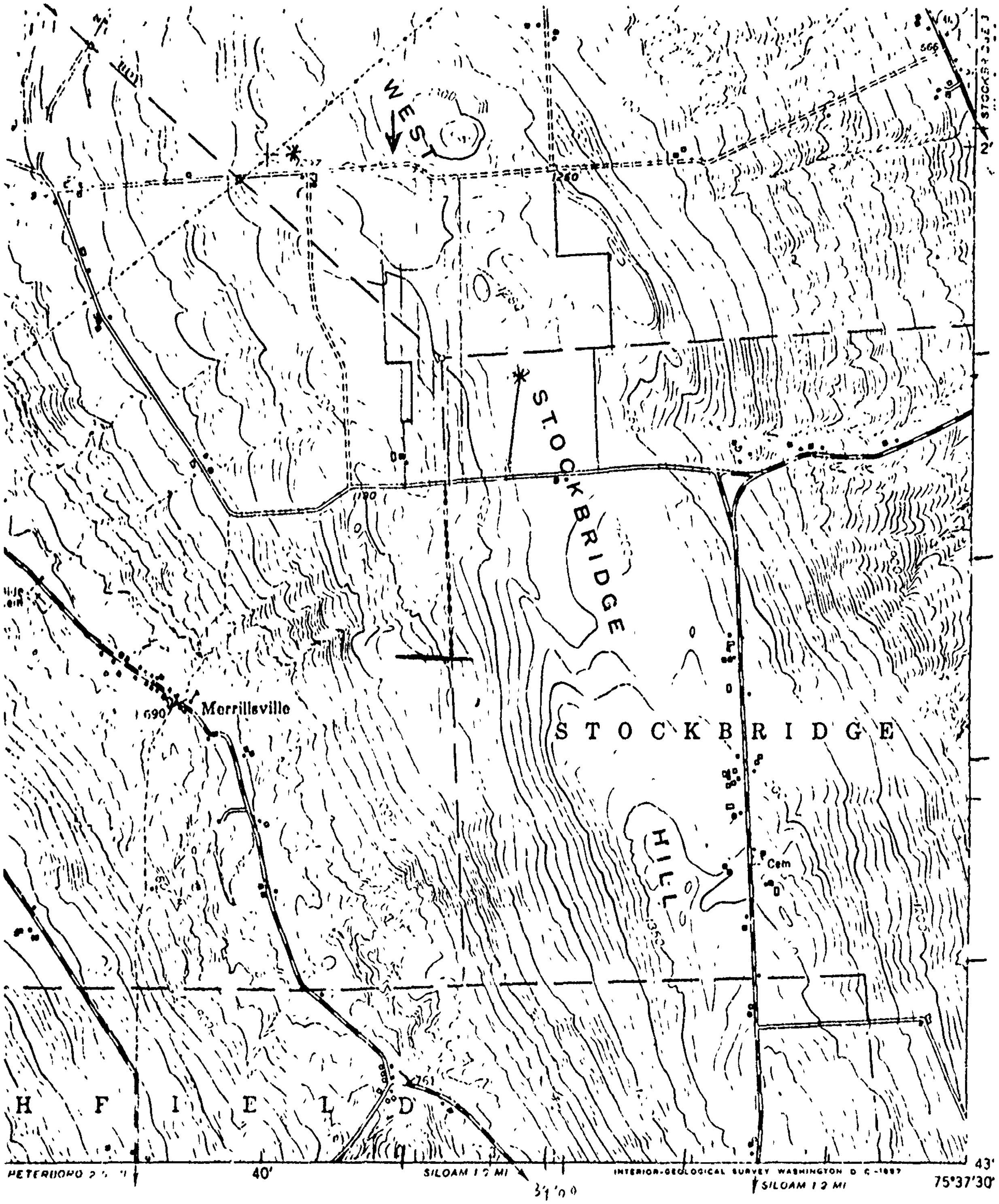
A - Geometric Test Array
C - Concrete Pad 60'x 60'
F - Fenced Cattle Lot 200'x 200'
M - Mowed Area 200'x 200'
P - Plowed Area 100'x 100'
T - Thermal Calib. (EGLIN)
R - Radar C. C. (Calib)

STOCKBRIDGE TEST SITE

Proposed Modifications and Flight Lines

6 Sept 78

Rome Research Corp.
Rome, N.Y.



1 MILE

5000 6000 7000 FEET

1 KILOMETER

ROAD CLASSIFICATION

Heavy duty ——— Light-duty ———

Medium duty ——— Unimproved dirt - - - - - - -

U S Route ( ) State Route

NEW YORK

ONEIDA, N Y.

STOCKBRIDGE SITE DATA COLLECTION PLAN FOR EGLIN

MISSION	TIME (HRS)	DEPRESSION	HEADING	LINES	TOTAL PASSES
1	0800	20^0	180^0	5	10
2	1300	20^0	180^0, 0^0	5	20
3	1600	20^0	180^0	5	10
4	0800	75^0	180^0	5	10
5	1300	75^0	180^0	5	10
6	1600	75^0	180^0	5	10
					70

LINES ARE 2 MILES LONG (1 MILE OVER SITE PLUS 1/2 MILE ON EACH END).

ALTITUDE: 270 FT ABOVE AVERAGE TERRAIN AT SITE

SLANT RANGE: 800 FT

TIMES ARE APPROXIMATE -- EARLY MORNING, MID-DAY, LATE AFTERNOON.

WEST FLIGHT LINE IS ~1000 FT FROM RADIO TOWER NW OF SITE.

PROPOSED
MODIFICATIONS TO STOCKBRIDGE SITE

MOD	SPECIFICATION	ESTIMATED COST*	COMMENTS
FENCED CATTLE LOT	METAL POSTS 200' x 200'	INSTALLATION: $1,000	MONTGOMERY WARD
	10 CATTLE 1-½ YR OLD 1000 LB	TRANSPORT CATTLE, FEED, WATER: ~$300	CURTIN BROTHERS FARM
PLOWED AREA	100' x 100'	~$150	CURTIN BROTHERS
MOWED AREA	200' x 200' 6 INCH GRASS	~$150	CURTIN BROTHERS
CONCRETE PAD	60' x 60' x 12"	$12,000	?

*NOTE: SUPPORT FUNDS AND COORDINATION REQUIRED.

FLIGHT LINES

STOCKBRIDGE TEST SITE

(See Map)

1. North-South line chosen to (a) minimize elevation changes during pass and (b) provide lateral clearance for radio tower and B-52 test towers.

2. Multiple lines chosen to insure coverage of area; 280 ft swath per pass with 50 ft overlap.

3. North to South direction on all runs to view sun illuminated sides of targets; direction of pass also reversed when at 20^{o} depression angle to view cooler side of targets.

4. Missions at 3 times of the day to obtain background temperature change data.

Wide Area Anti-Armor Munition (WAAM) Program

ANALOG STUDY

ROME, NEW YORK AREA
VS
WEST GERMANY

ANALOG REQUIREMENT

AN EQUIVALENCE OF PERFORMANCE (TARGET DETECTION AND FALSE ALARM) FOR WAAM-TYPE IR & MMW SENSORS

POSTULATE: AN EQUIVALENCE OF PERFORMANCE WILL EXIST IF THE TYPE AND DISTRIBUTION OF SENSIBLE IR AND MMW RADIATION BOUNDARIES IS EQUIVALENT.

SCENE FACTORS FOR RADIANCE DISTRIBUTIONS

- Local Relief Features
- Natural Vegetation Communities
- Agricultural Crops and Practices
  - Intensity of agriculture
  - Field sizes, patterns, boundaries
- Cultural Features and Practices
  - Road materials and borders
  - Building dispersion and materials
- Weather Environment

APPROACH TO ANALOG STUDY

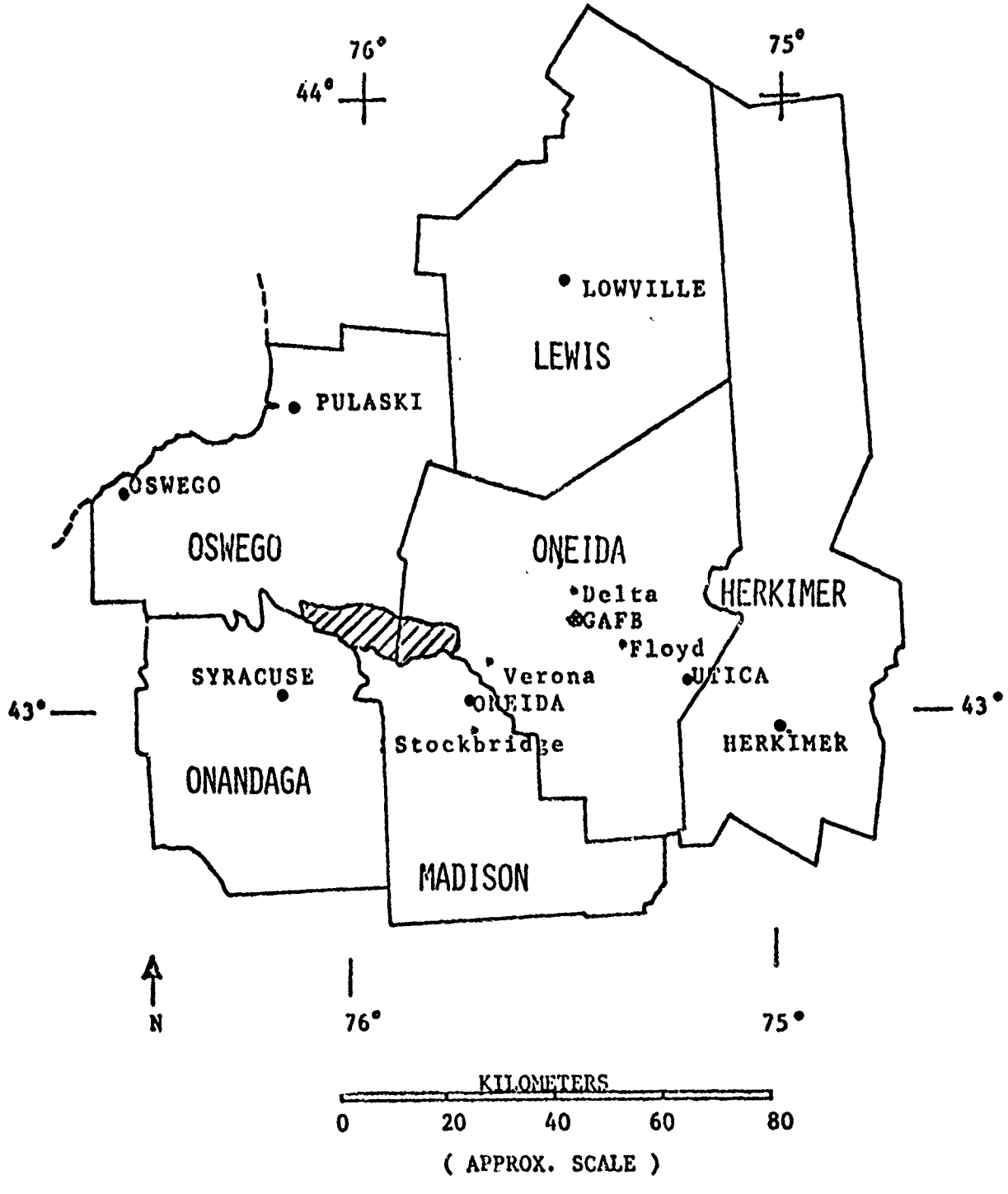
- IDENTIFY AND EVALUATE RELEVANCE OF PREVIOUS STUDIES
- AUGMENT AS NEEDED BY COLLATING EXISTING INFORMATION OF SCENE FACTOR DISTRIBUTION

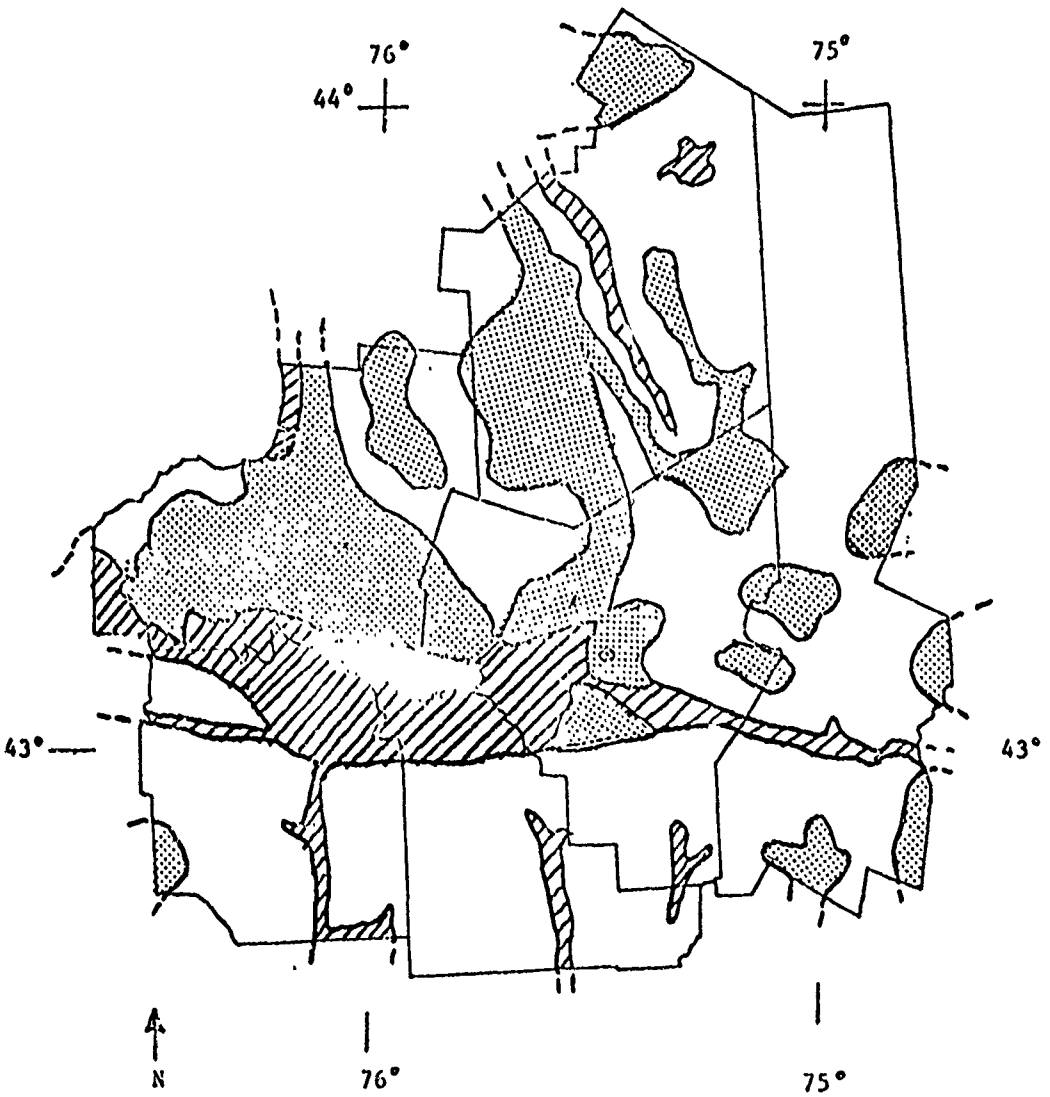
PREVIOUS ANALOG STUDIES

NORTHEAST TEST AREA
(RECONNAISANCE-ORIENTED ANALOG)

- GROSS TERRAIN RELIEF TYPES
- GROSS DISTRIBUTION OF MAJOR CITIES
- PRESENCE OF MAJOR ROADS, RIVERS AND CANALS
- PRESENCE OF STRATEGIC AND TACTICAL TARGET ANALOGS
- GROSS SIMILARITY OF WEATHER ENVIRONMENT

DID NOT IDENTIFY THE CORRELATED DISTRIBUTIONS OF WAAM-IMPORTANT SCENE FACTORS.


76°
44°
75°
LOWVILLE
LEWIS
PULASKI
OSWEGO
OSWEGO
ONEIDA
Delta
GAFB
Floyd
HERKIMER
SYRACUSE
Verona
UTICA
43°
ONEIDA
43°
Stockbridge
HERKIMER
ONANDAGA
MADISON
N
76°
75°
KILOMETERS
0
20
40
60
80
(APPROX. SCALE)



KILOMETERS

0 20 40 60 80

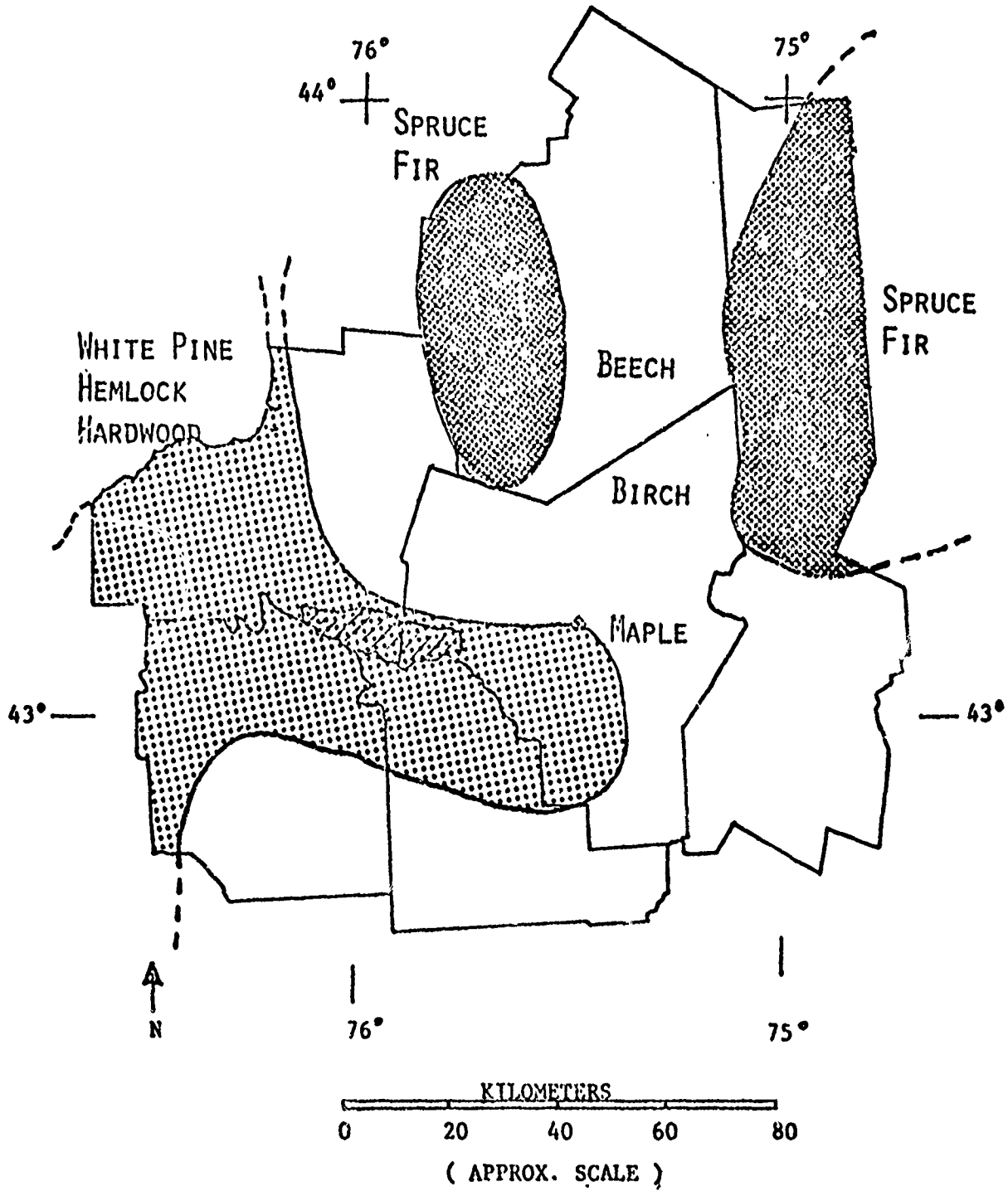
(APPROX. SCALE)

LEVEL PLAINS

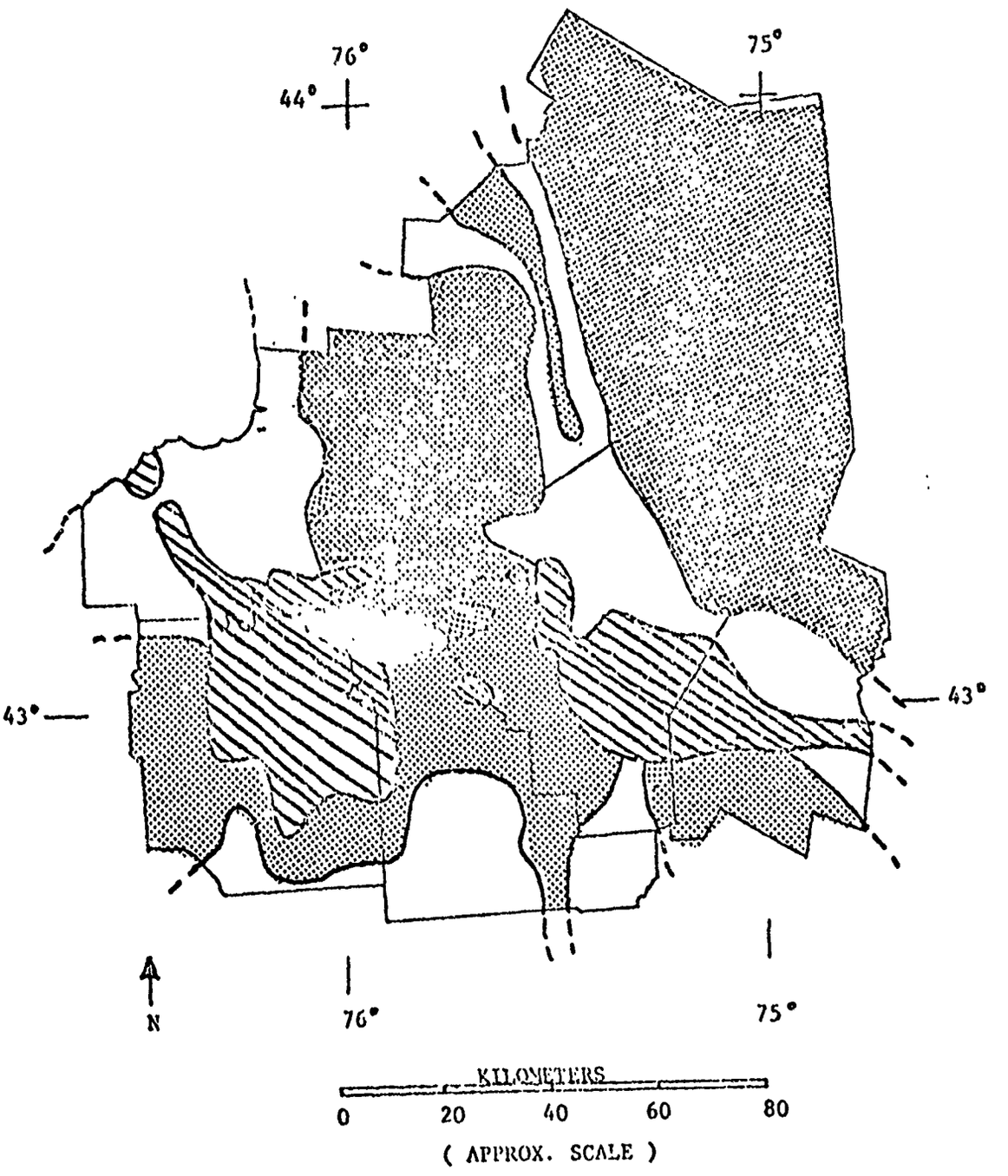
HILLS, MODERATE SLOPES & MEDIUM LOCAL RELIEF

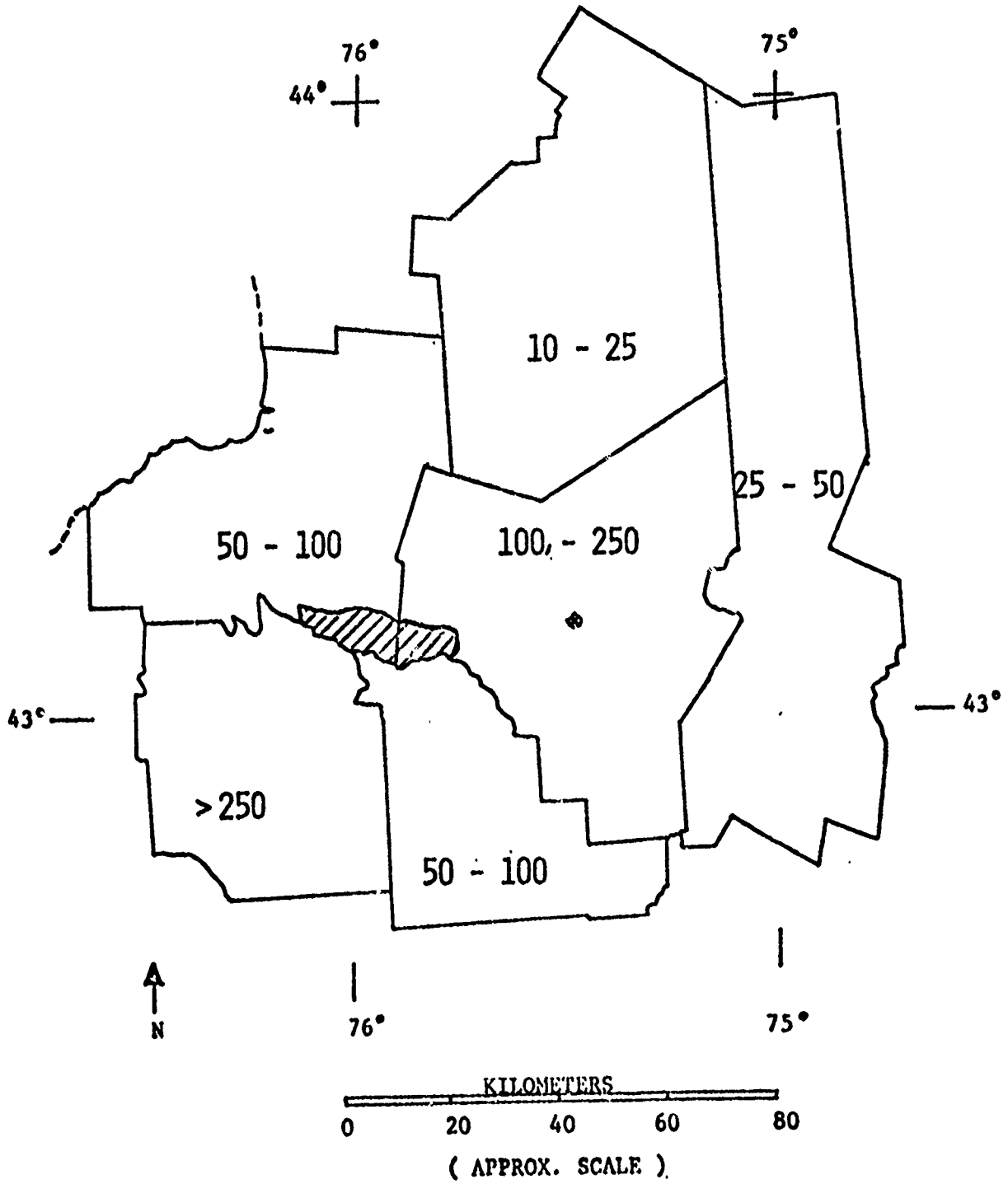
ROLLING PLAINS, GENTLE SLOPES & LOW LOCAL RELIEF

ROUNDED MTS., STEEP SLOPES & HIGH LOCAL RELIEF

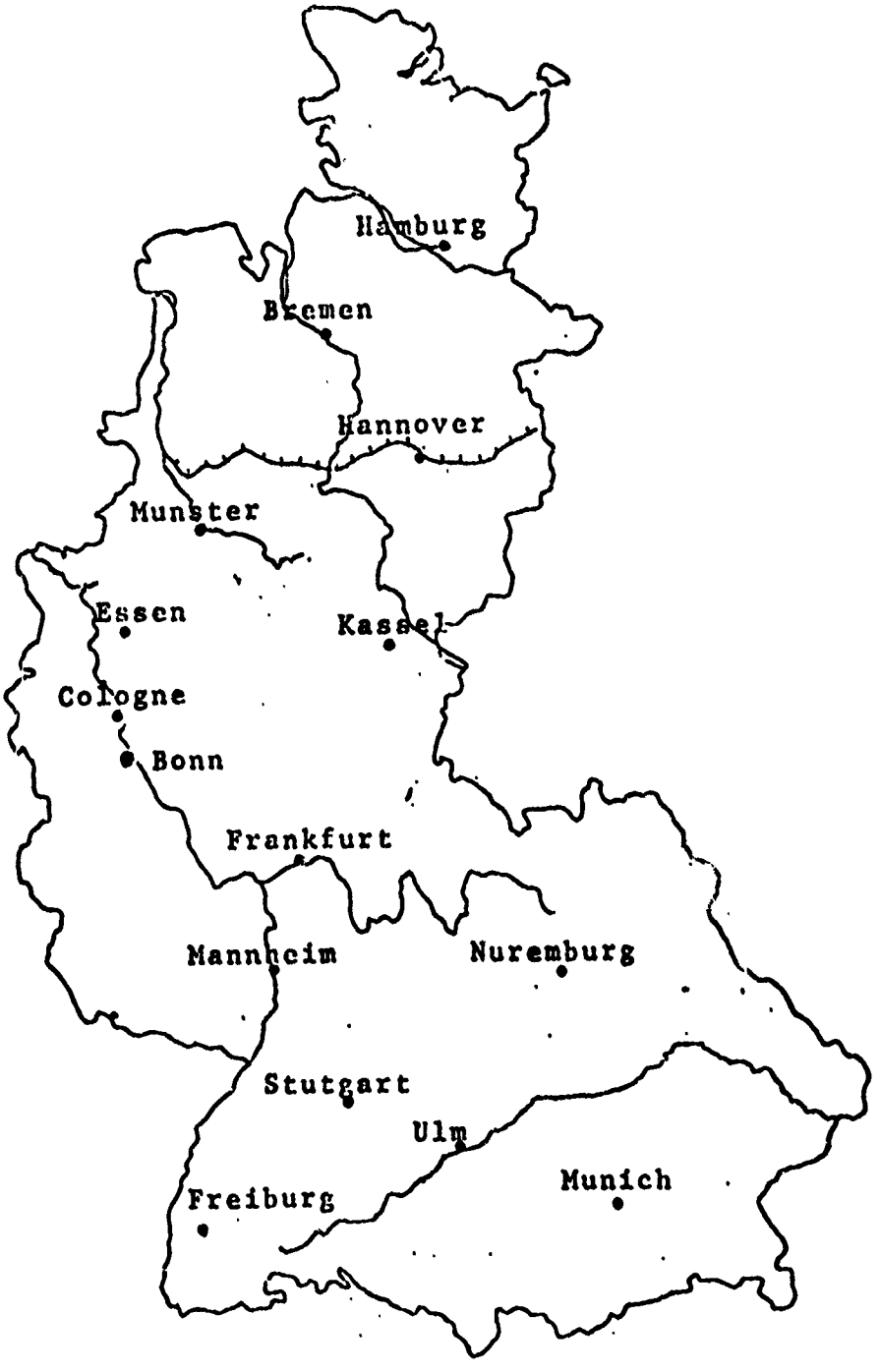


VEGETATION REGIONS

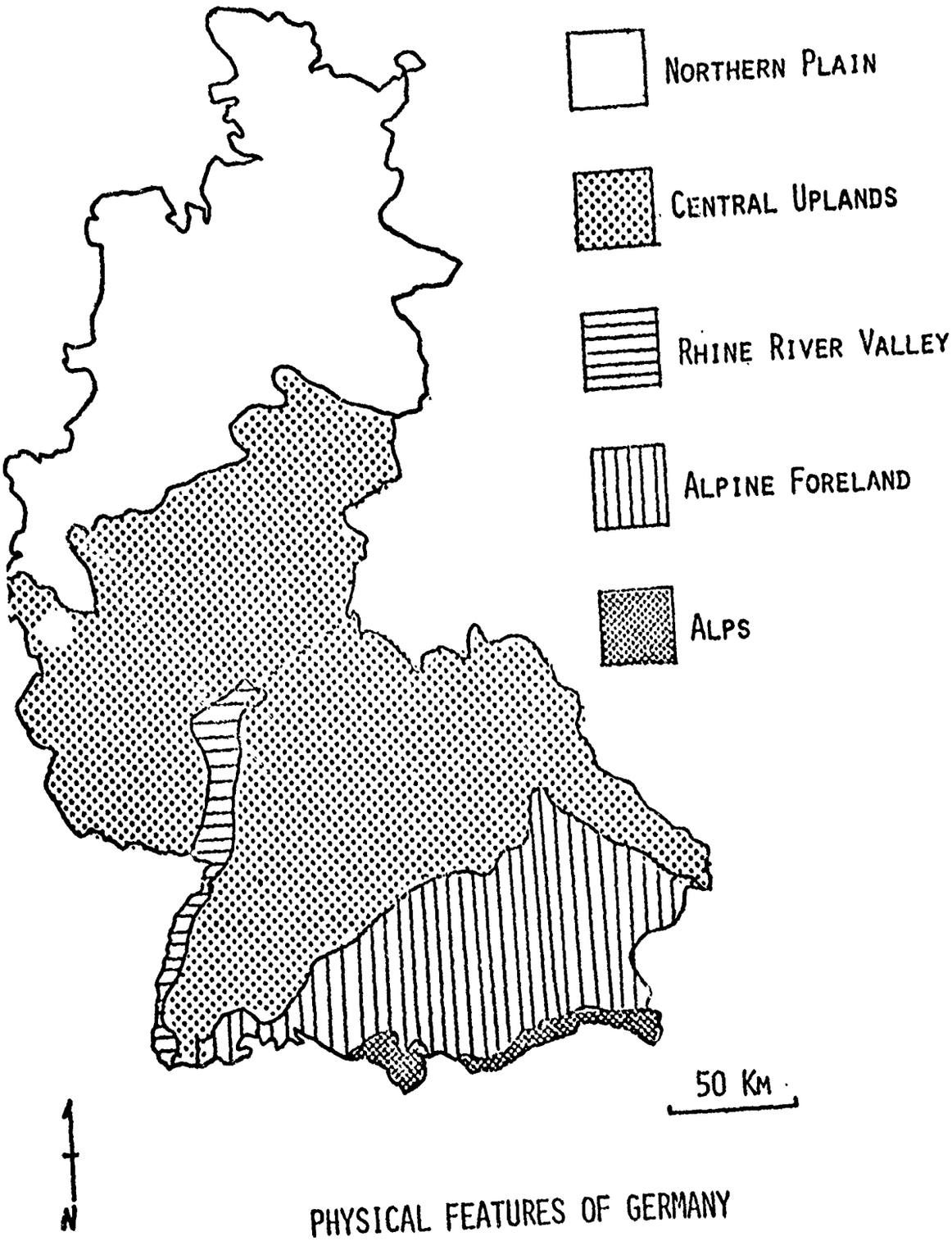

76°
44°
75°
43°
43°
N
76°
75°
KILOMETERS
0
20
40
60
80
(APPROX. SCALE)
75% TOTAL AREA IN FARMS
LESS THAN 10% FARMS
55% FARMS
URBAN



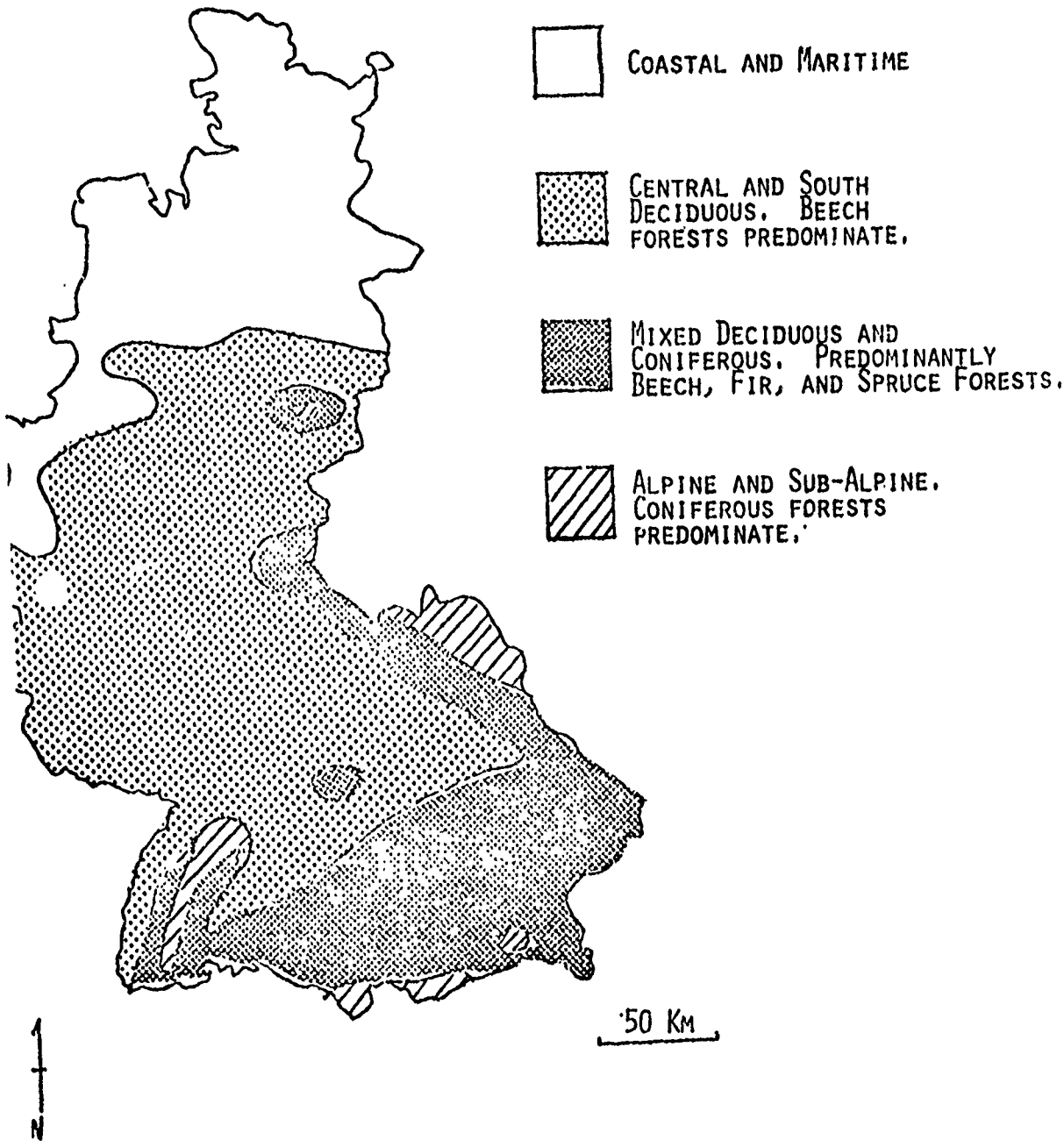
POPULATION PER SQUARE MILE



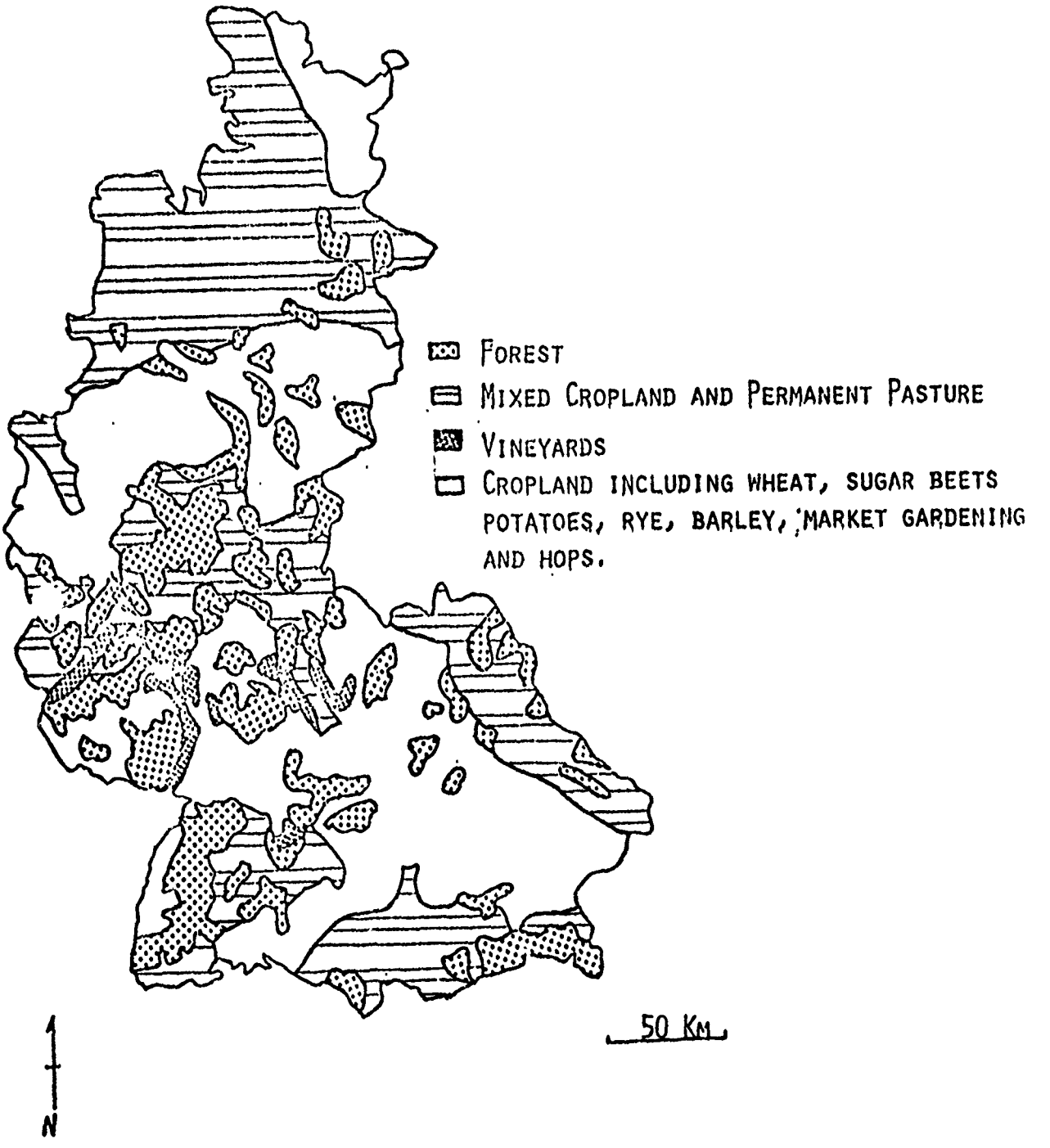
FEDERAL REPUBLIC OF GERMANY



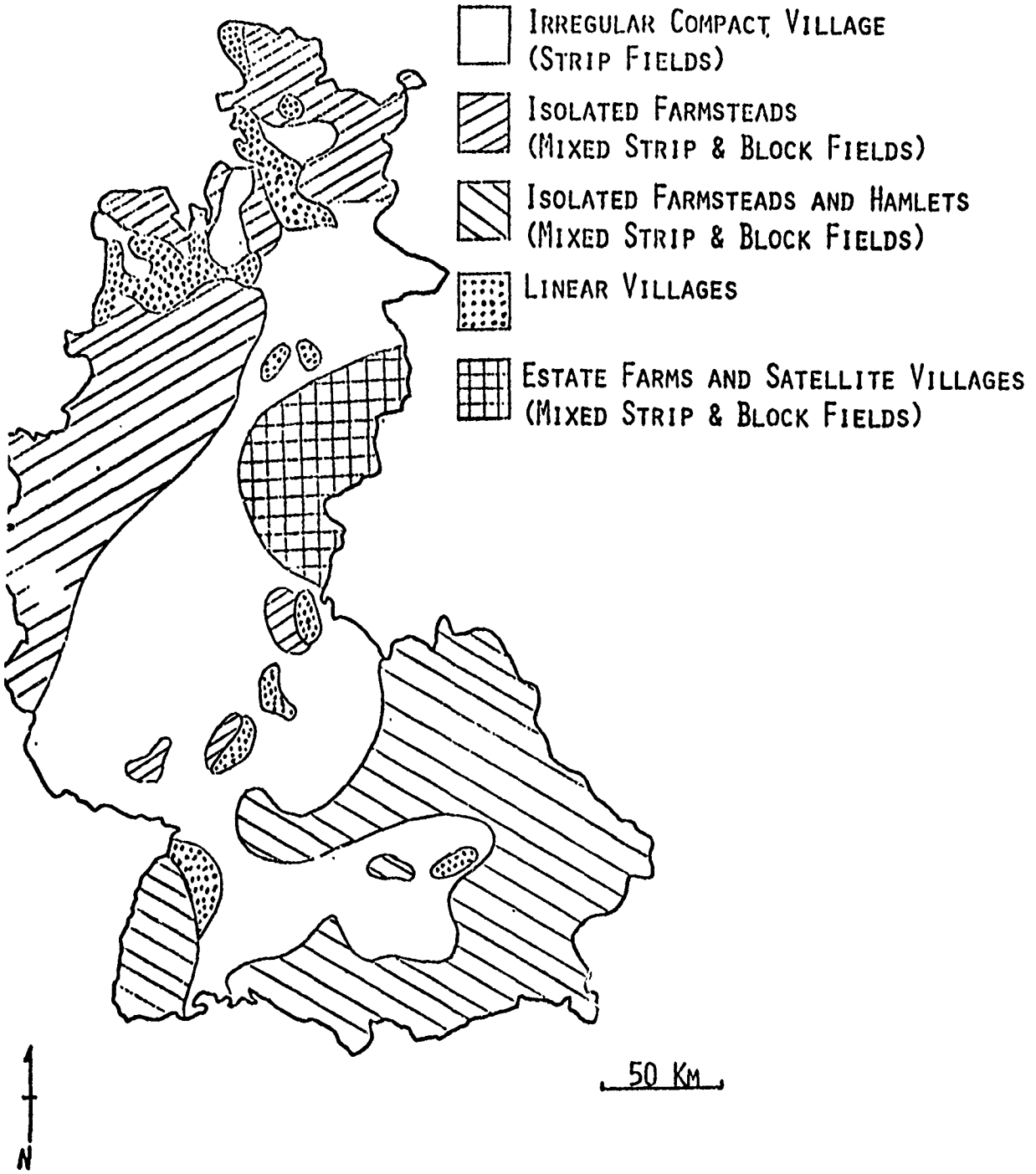
PHYSICAL FEATURES OF GERMANY



WEST GERMANY VEGETATION REGIONS



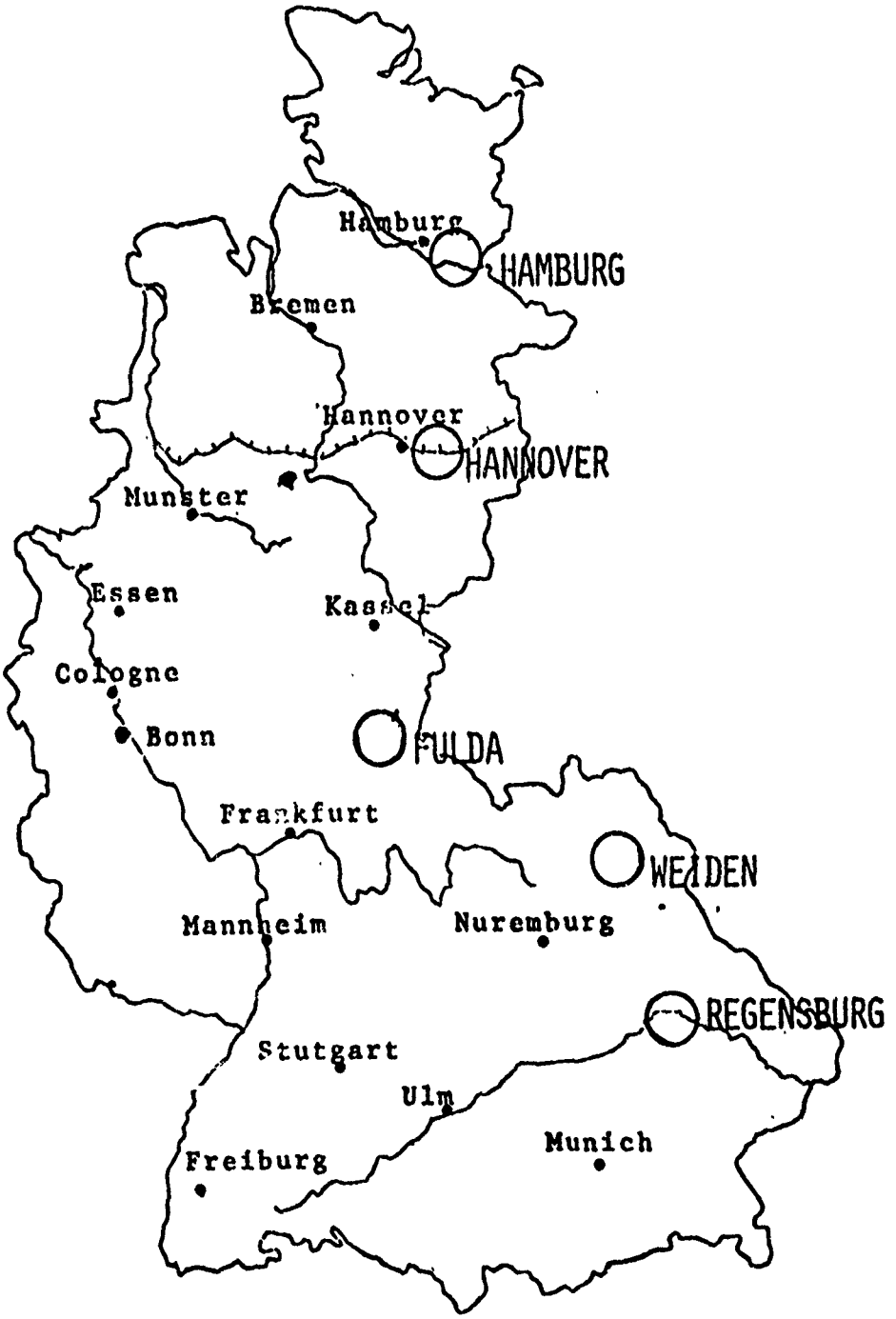
GERMANY - LAND USE



DOMINANT RURAL SETTLEMENTS

GERMANY

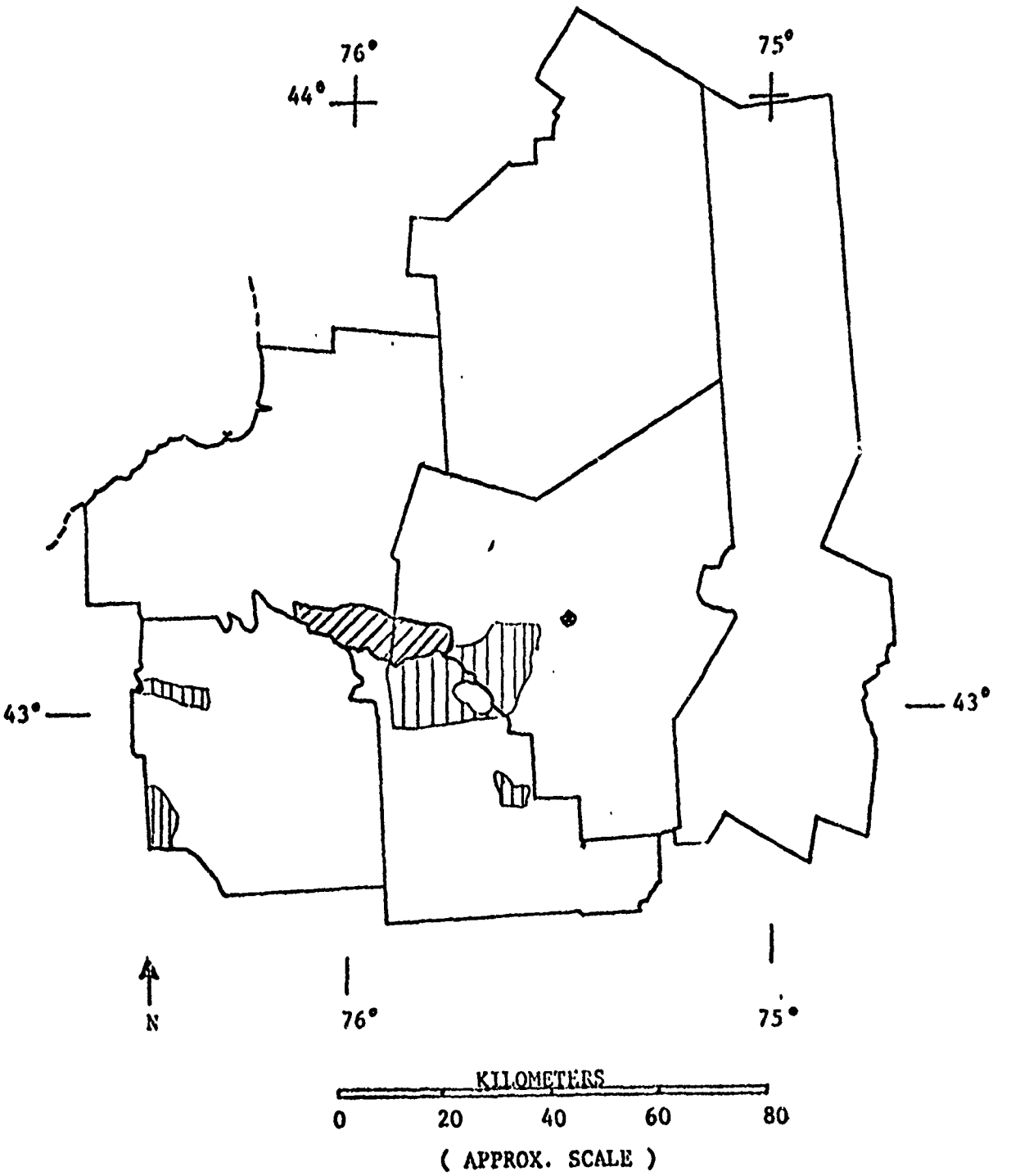
FOCUS OF EVALUATION



FEDERAL REPUBLIC OF GERMANY

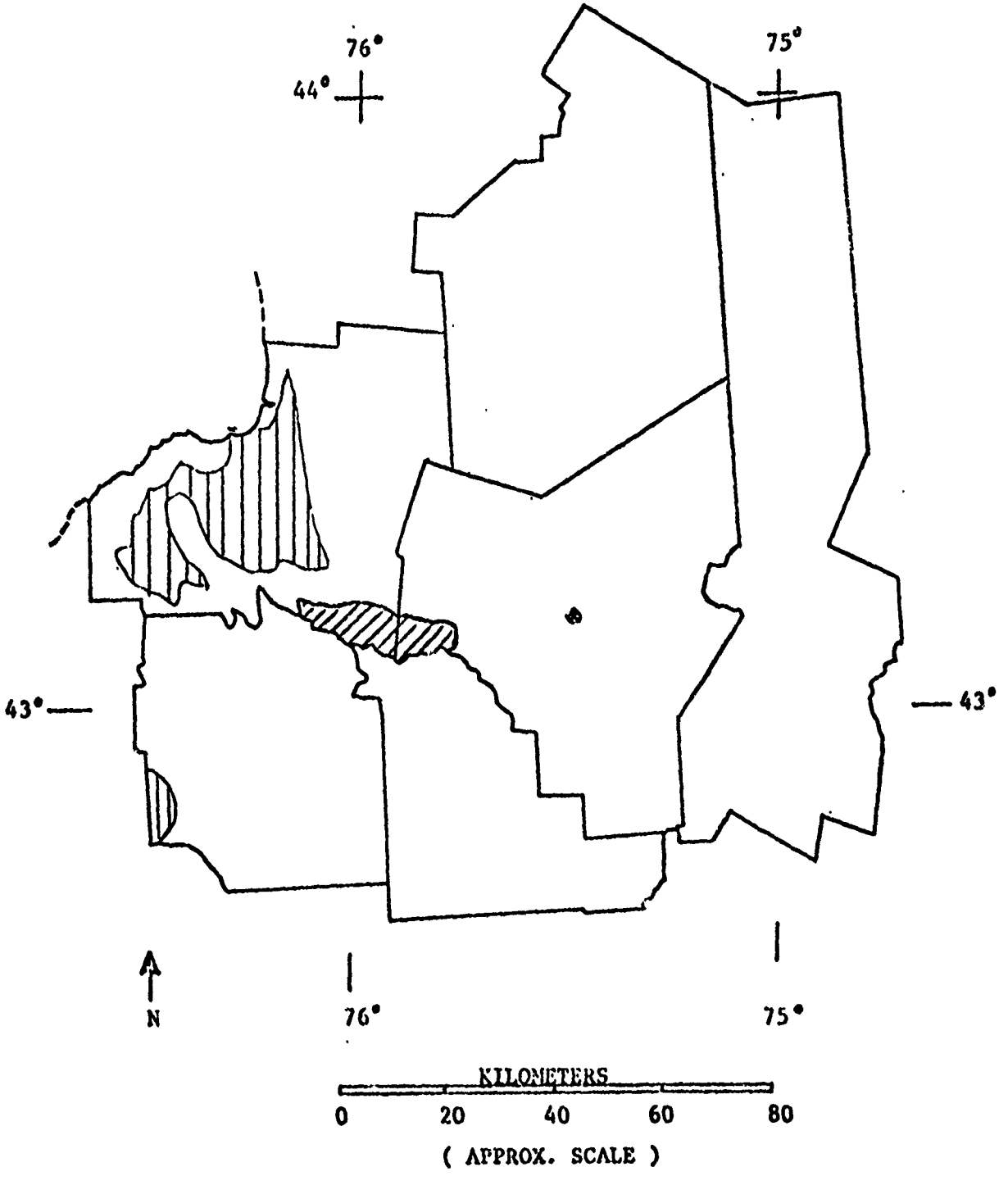
ANALOG

ELBE RIVER APPROACH TO HAMBURG



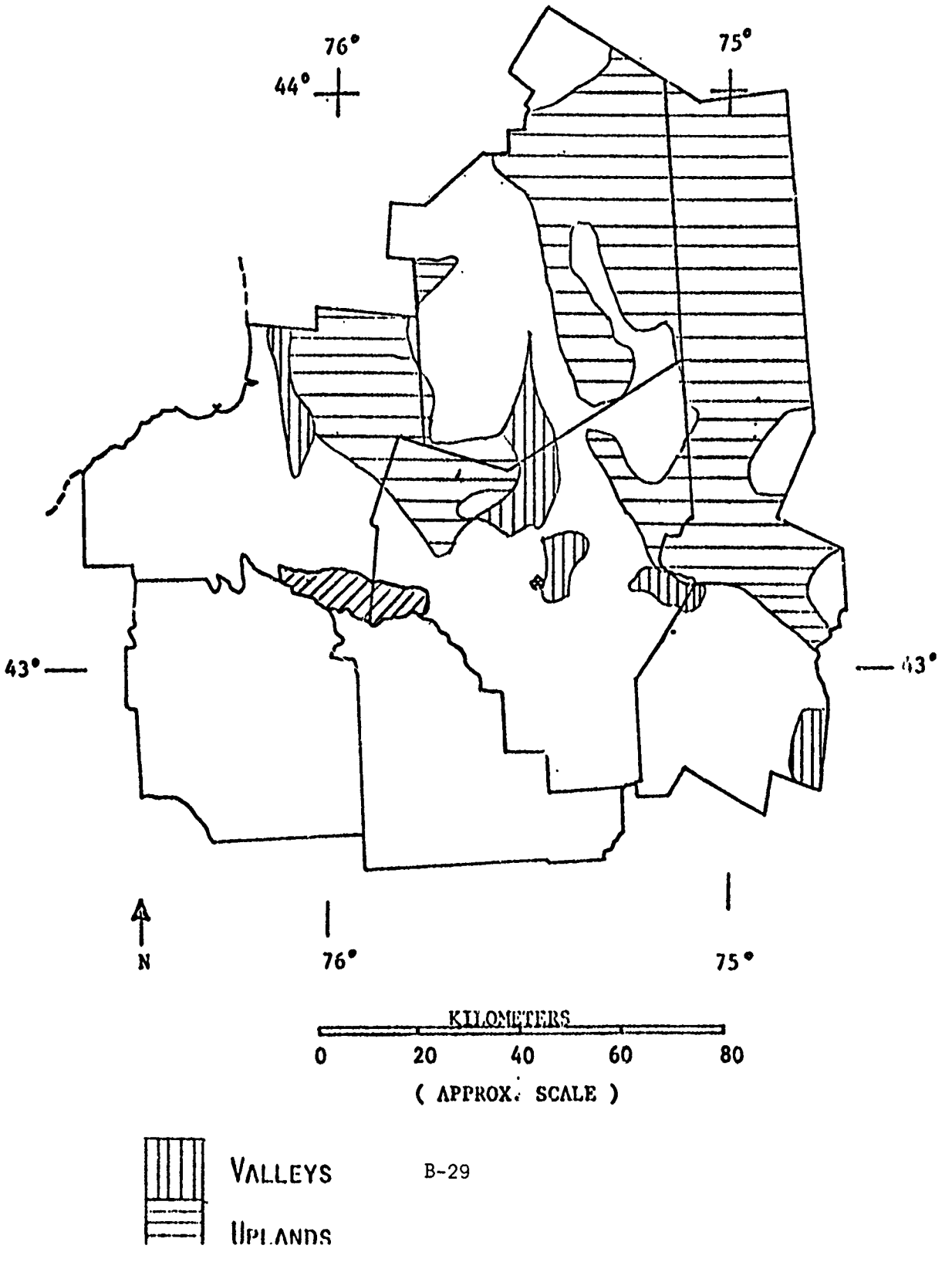
ANALOG

AUTOBAHN APPROACH TO HANNOVER



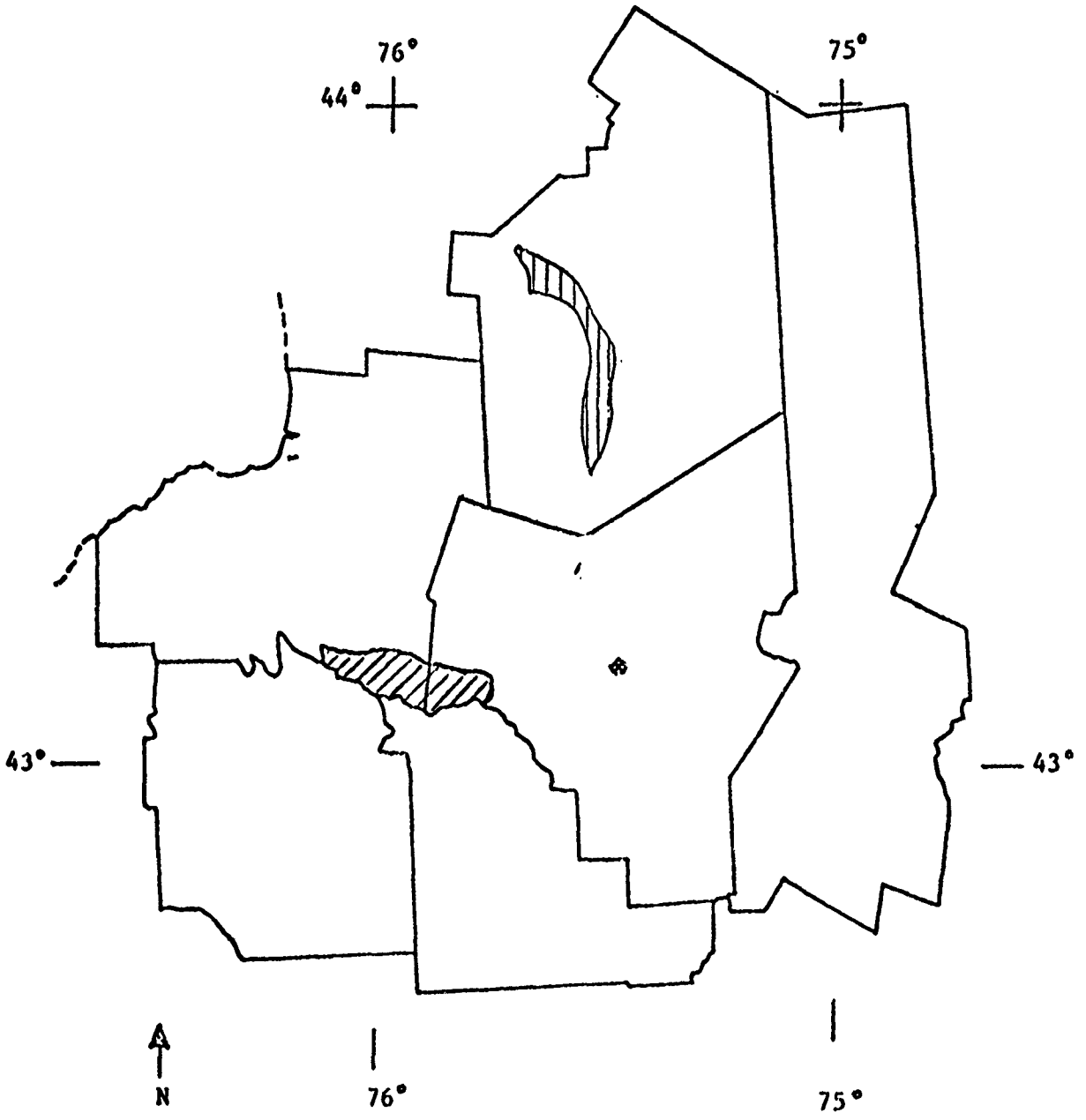
ANALOG

FULDA APPROACH TO RHINE VALLEY



ANALOG

WEIDEN/REGENSBURG APPROACH TO RHINE VALLEY



ANALOG STUDY CONCLUSION

- A NUMBER OF POTENTIAL ANALOG AREAS EXIST WITHIN 50 MILES OF RADC

- THESE AREAS EXHIBIT SCENE FACTOR CO-OCCURRENCES TYPICAL OF MOST OF THE FRG REGIONS BORDERING THE GDR

- LOCALIZED SITE SELECTION WITHIN ANALOG AREAS MUST BE DONE WITH CARE

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